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HANDBOOK OF THE INFRARED OPTICAL PROPERTIES OF A1203, CARBON, MGO, AND ZRO2. VOLUME I

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Aerospace Corporation

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Approved

S. Siegel, Director
Chemistry and Physics Laboratory

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This handbook presents the compiled results of a comprehensive survey of the open literature relevant to the infrared optical properties of aluminum oxide, carbon, magnesium oxide, and zirconium dioxide. Literature data were critically reviewed and representative data chosen on mathematically constructed for refractive and extinction indices, spectral and total emissivities, reflectance, and transmittance over the 1 to 1000 μm spectral range. All data are presented in both graphic and tabular format, and a cross-referenced bibliography is included.

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INTRODUCTION

This report is the compiled results of the comprehensive literature search performed for the Particle Optical Properties Measurements (POPM) program. All data relevant to the infrared optical properties of aluminum oxide, carbon, magnesium oxide, and zirconium dioxide found in the search were critically evaluated and summarized. These data were carefully reviewed and the "best" data for each material were selected. On the basis of this review, areas in which further research is required were noted.

The report is divided into three major sections: Section I contains the representative or "best" data for the refractive index, extinction index, spectral and total emissivities, reflectance, and transmittance of each material; Section II lists all relevant literature found in the search; and Section III presents in tabular and graphic formats the digitized data from the literature. Each major section is divided by material into categories that are further divided by optical property.

It would be useful if, for all surveyed data, a meaningful estimate of experimental error could be made. An examination of the literature revealed that error analyses are seldom included in papers, and even descriptions of experimental apparatus and procedures are often lacking. This greatly hampers the proper evaluation of published data, and in many cases has necessitated the use of a comparison technique. The method used to construct each representative curve is described in Section I and in general consists of either a mathematical fit to collections of data points from many sources, or selections of "best" data connected to form broad coverage over a temperature or spectral range. The rationale for including Section III, with its many sets of tabulated data, is to permit the user of this handbook to use data gathered for specific types of materials.

Wherever possible the data in this handbook were taken from published tables. Where these were not available, the curves in the literature were linearly enlarged and digitized using an Oscillogram and Film Semi-Automatic Reader (OSCAR), manufactured by Benson-Lehner Corporation. It is felt that the uncertainties in the tabulated data arise principally from basic experimental errors and journal reproduction uncertainties. Digitization was done over the complex spectra in such a way that a linear interpolation between

points would be valid, so in spectral regions that are highly structured the digitized points are densely packed and in smooth regions the points are widely spaced. The abstract accompanying the tabulated data in Section III identifies those data sets where the digitization was of discrete points in the original papers.

A few remarks concerning the notation used in this handbook need to be made. First, the actual numerical values of the optical parameters are listed in the tables, except for R and T, which in the tables are listed in percent and thus have values between 0 and 100. Second, the extinction index, k, is consistently presented here, even when the original published data were given as the absorption coefficient, α. k and α are related by the expression,

$$k = \frac{\lambda}{4\pi} \alpha .$$

α is conventionally given in units of cm^{-1}, in which case λ must be given in cm ($1\mu = 10^{-4}$ cm).

Symbols Used in this Handbook

λ:	Wavelength (microns)
T:	Temperature (degrees Kelvin, ^{o}K)
n:	Refractive index (dimensionless)
k:	Extinction index (dimensionless)
α:	Absorption coefficient (cm^{-1} or mm^{-1})
$\epsilon(\lambda)$:	Spectral emissivity (tabulated in percent)
$\epsilon(T)$:	Total hemispherical emissivity (tabulated in percent)
R:	Reflectance (tabulated in percent)
TR:	Transmittance (tabulated in percent)

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*NOTE ADDED IN PROOF CONCERNING A NEW REFERENCE

D. P. DeWitt, Handbook of the Optical, Thermal and Mechanical Properties of Six Polycrystalline Dielectric Materials, Purdue Univ. Thermophys. Prop. Res. Ctr., TPRC - Report 19, Dec., 1972.

In this handbook, the refractive and extinction indices, transmittance, emittance, reflectance, absorptance, and scattering coefficient for aluminum oxide, calcium fluoride, magnesium fluoride, magnesium oxide, silicon dioxide, and titanium dioxide are presented. These data have been gathered from open literature sources, many of which are presented and evaluated in the present Aerospace Corp. /AFRPL handbook. This reference provides an excellent general survey of aluminum and magnesium oxide properties over, in the main, the short to medium infrared spectral regions, but no attempt has been made to produce digitized data sets for the source data, or to provide sets of representative optical properties, as has been done in the present report.

I-1 ALUMINUM OXIDE PROPERTIES

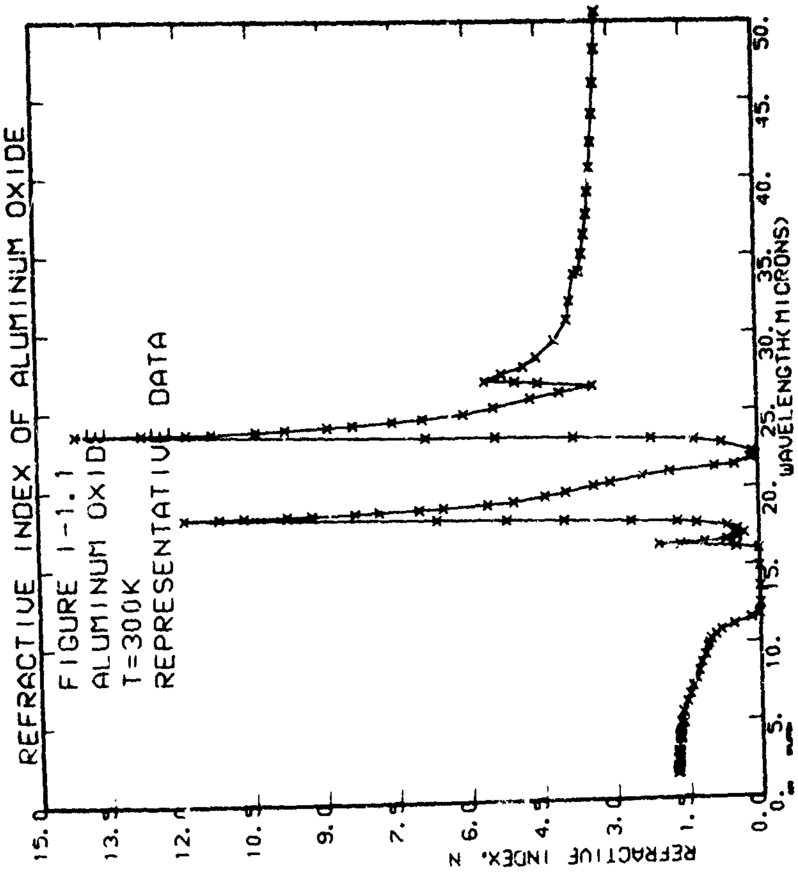
I-1.1 Refractive Index, n — Aluminum Oxide

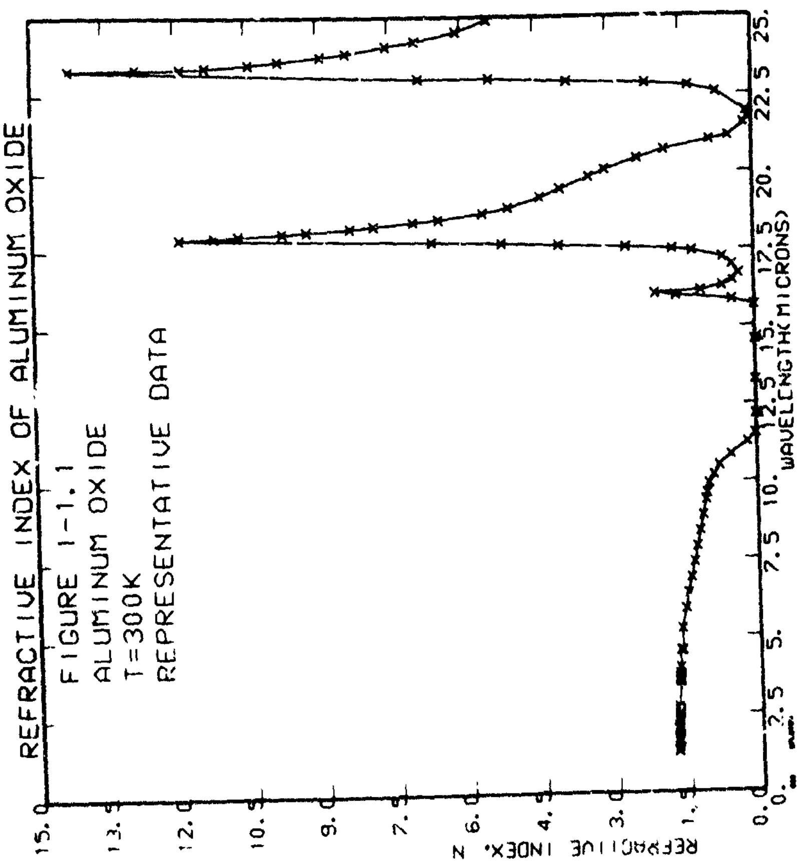
The refractive index of sapphire has been extensively studied at T = 300°K, but data for other temperatures are sparse. Piriou (Ref. 1N-9) has studied sapphire at 1773°K from 9μ to 33μ, and Loewenstein (Ref. 1N-3) at T = 1.5°K. Their results indicate that the refractive index changes very little with temperature except near resonant lattice frequencies. A representative curve for sapphire at T = 300°K has been constructed using the data from references 1N-3, 1N-5, 1N-9, and 1N-11. No bulk alumina refractive index data were located in the literature, and refractive index data for powders were found only in Streed (Ref. 1N-12) and are of uncertain value, since the sapphire refractive index reported in this source was greatly at variance with all other measurements. No experimental measurements of n from 6μ to 9μ, aside from Reference 1N-12, have been located, and the representative curve has been constructed in this region by linear interpolation. Where the ordinary and extraordinary indices have been measured (~30μ and longer), the ordinary value of n has been used. All measured values of n_o and n_e are tabulated in Section III-1.1.

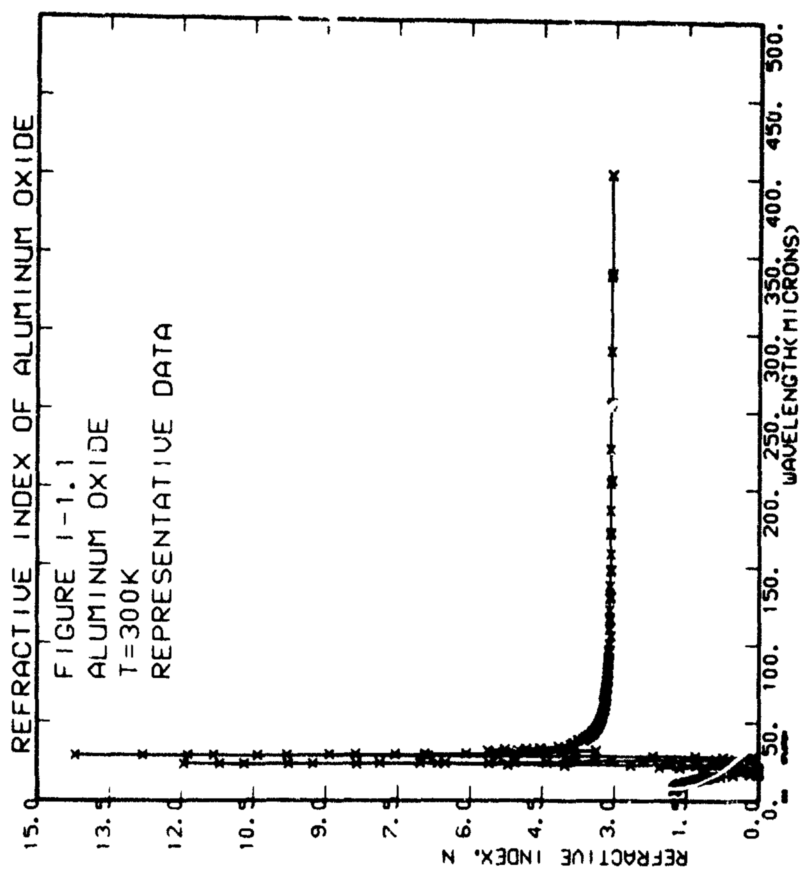
The representative curve is shown in Figure I-1.1 and is tabulated in Table I-1.1. Section I-1.7 gives in tabular form the lattice frequencies of aluminum oxide which relate to the structure seen in the optical properties curves.

Table I-1.1 Aluminum Oxide Refractive Index - Representative Data

λ	n	λ	n	λ	n	λ	n
1.014	1.755E+00	1.129	1.753E+00	1.367	1.749E+00	1.395	1.749E+00
1.529	1.747E+00	1.693	1.744E+00	1.709	1.743E+00	1.813	1.741E+00
1.970	1.738E+00	2.153	1.734E+00	2.249	1.732E+00	2.325	1.731E+00
2.437	1.729E+00	3.244	1.704E+00	3.267	1.704E+00	3.303	1.702E+00
3.330	1.701E+00	3.422	1.698E+00	3.507	1.695E+00	3.707	1.688E+00
4.255	1.664E+00	4.272	1.627E+00	4.954	1.627E+00	5.600	1.542E+00
6.100	1.477E+00	6.600	1.411E+00	7.100	1.346E+00	7.600	1.280E+00
8.100	1.214E+00	8.600	1.148E+00	9.111	1.081E+00	9.317	1.054E+00
9.[illegible]39	1.012E+00	9.906	9.106E-01	10.200	7.857E-01	10.552	5.293E-01
10.956	1.874E-01	11.223	1.640E-02	11.863	1.320E-02	12.964	1.320E-02
14.272	1.320E-02	15.395	6.600E-03	15.569	4.504E-01	15.719	1.631E+00
15.793	2.059E+00	15.858	1.111E+00	16.007	6.476E-01	16.184	4.372E-01
16.399	3.024E-01	16.678	4.438E-01	16.940	6.377E-01	17.138	1.275E+00
17.211	1.686E+00	17.274	2.646E+00	17.359	4.020E+00	17.425	5.218E+00
17.483	[illegible]	17.621	1.195E+01	17.666	1.119E+01	17.702	1.068E+01
17.789	9.772E+00	17.840	9.263E+00	17.927	8.341E+00	18.012	7.862E+00
18.134	7.022E+00	18.221	6.510E+00	18.406	5.605E+00	18.581	5.066E+00
18.916	4.395E+00	19.174	3.988E+00	19.554	3.399E+00	19.782	3.044E+00
20.147	2.396E+00	20.422	1.828E+00	20.717	8.777E-01	20.833	4.668E-01
21.246	1.611E-01	21.437	6.250E-02	21.647	1.183E-01	22.252	7.232E-01
22.472	1.315E+00	22.554	2.202E+00	22.647	3.813E+00	22.727	5.416E+00
22.731	6.873E+00	23.017	1.421E+01	23.049	1.280E+01	23.069	1.187E+01
23.100	1.133E+01	23.216	1.042E+01	23.314	9.798E+00	23.466	8.319E+00
23.563	[illegible]	23.779	7.545E+00	23.937	6.940E+00	24.227	6.077E+00
24.617	5.453E+00	25.193	4.681E+00	25.589	4.086E+00	25.969	3.376E+00
26.182	4.517E+00	26.276	5.007E+00	26.323	5.628E+00	26.780	5.274E+00
27.227	4.826E+00	27.307	4.530E+00	28.901	4.158E+00	30.204	3.905E+00
31.407	3.843E+00	33.190	3.761E+00	33.330	3.630E+00	33.333	3.636E+00
34.430	3.578E+00	34.483	3.578E+00	35.710	3.522E+00	35.714	3.522E+00
37.037	3.451E+00	37.040	3.451E+00	38.460	3.428E+00	39.462	3.428E+00
40.000	3.385E+00	41.667	3.350E+00	41.670	3.350E+00	43.478	3.320E+00
43.480	3.320E+00	45.455	3.287E+00	45.460	3.287E+00	47.619	3.260E+00
47.620	3.260E+00	50.000	3.24[illegible]E+00	52.630	3.220E+00	52.632	3.220E+00
55.556	3.198E+00	55.560	3.198E+00	56.689	3.211E+00	58.377	3.202E+00
58.824	3.18[illegible]	60.132	3.192E+00	61.996	3.185E+00	62.500	3.167E+00
64.020	3.176E+00	66.138	3.170E+00	66.667	3.147E+00	68.446	3.162E+00
70.872	3.155E+00	71.429	3.132E+00	73.475	3.148E+00	76.336	3.142E+00
76.923	3.119E+00	79.365	3.136E+00	82.713	3.130E+00	83.333	3.106E+00
86.281	3.125E+00	90.171	3.120E+00	90.909	3.096E+00	94.518	3.115E+00
100.000	3.097E+00	104.380	3.106E+00	110.250	3.102E+00	111.110	3.079E+00
116.690	3.098E+00	124.070	3.094E+00	125.000	3.073E+00	132.280	3.091E+00
141.650	3.087E+00	142.860	3.068E+00	152.670	3.084E+00	165.290	3.082E+00
166.670	3.062E+00	1[illegible].510	3.079E+00	198.410	3.077E+00	200.000	3.058E+00
220.260	3.075E+00	248.140	3.074E+00	250.000	3.055E+00	283.290	3.072E+00
331.130	3.070E+00	333.330	3.052E+00	396.830	3.070E+00		


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE I-1.1
ALUMINUM OXIDE
T=300K
REPRESENTATIVE DATA
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE I-1.1
ALUMINUM OXIDE
T=300K
REPRESENTATIVE DATA
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE I-1.1
ALUMINUM OXIDE
T=300K
REPRESENTATIVE DATA
REFRACTIVE INDEX, N
WAVELENGTH (MICRONS)

I-1.2 Extinction Index, k - Aluminum Oxide

Figure I-1.2 shows the representative curve for the extinction index of high-density alumina and sapphire at T = 300°K, constructed from the data of Grimm (Ref. 1K-1), Piriou (Ref. 1K-12, 1K-13) and Loewenstein (Ref. 1K-5) for the spectral range 2μ to 340μ. Small changes in k do occur and these are presented in Section III - 1.2 showing the temperature effect to 2300°K. All values of k are for the ordinary ray; extraordinary ray data is located in Section III-1.2.

Only one reference, 1K-4, was found for the thin film extinction index, and one, 1K-16, for powdered alumina, and these are summarized in Section III-1.2. Reference 1K-16 is of uncertain value for powdered alumina, since the values of k reported for sapphire in this reference deviate considerably from all other published values.

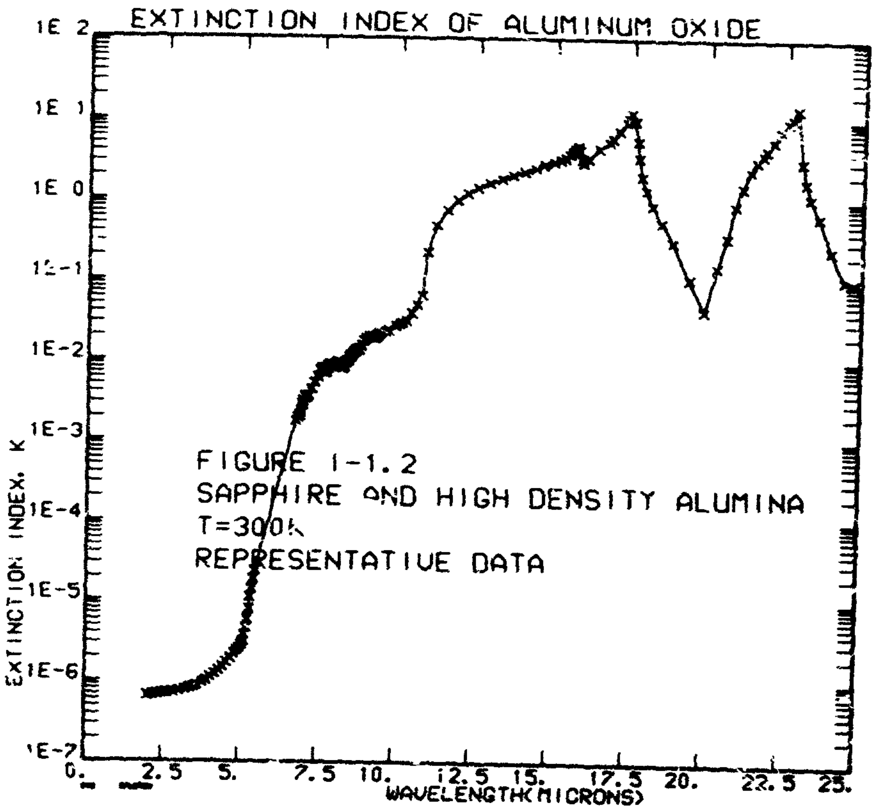
Section I-1.7 contains absorption peak information showing where fine structure in the extinction index is to be expected. Section I-1.6 gives transmittance data that also shows spectral regions having fine structure, and also gives powder transmittance data.

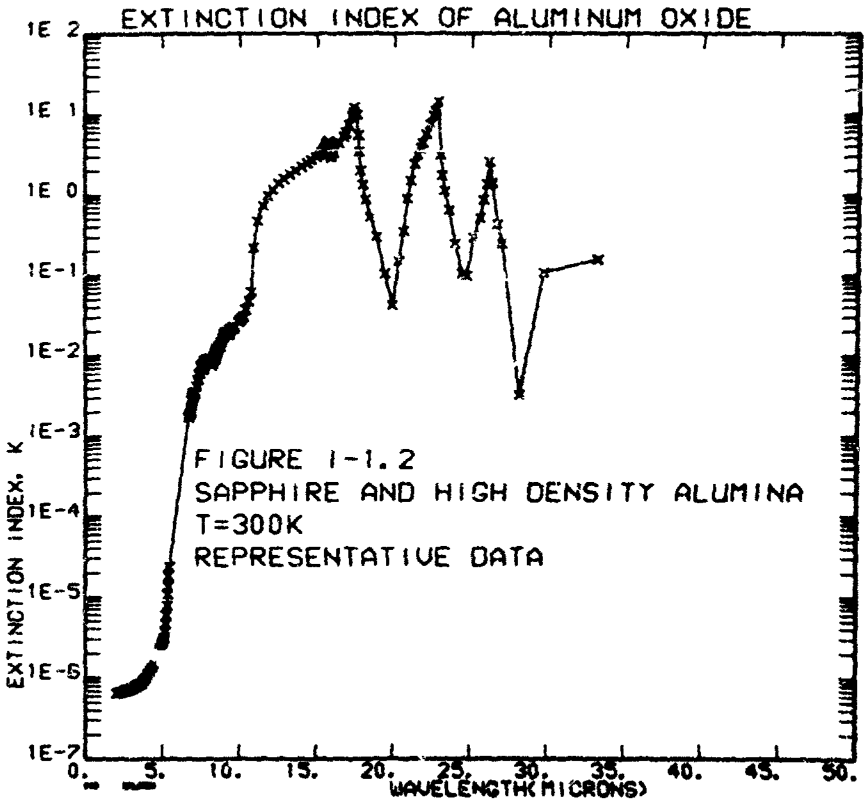
Table I-1.2 The Extinction Index of High Density Alumina and Sapphire at $300^{\circ}K$

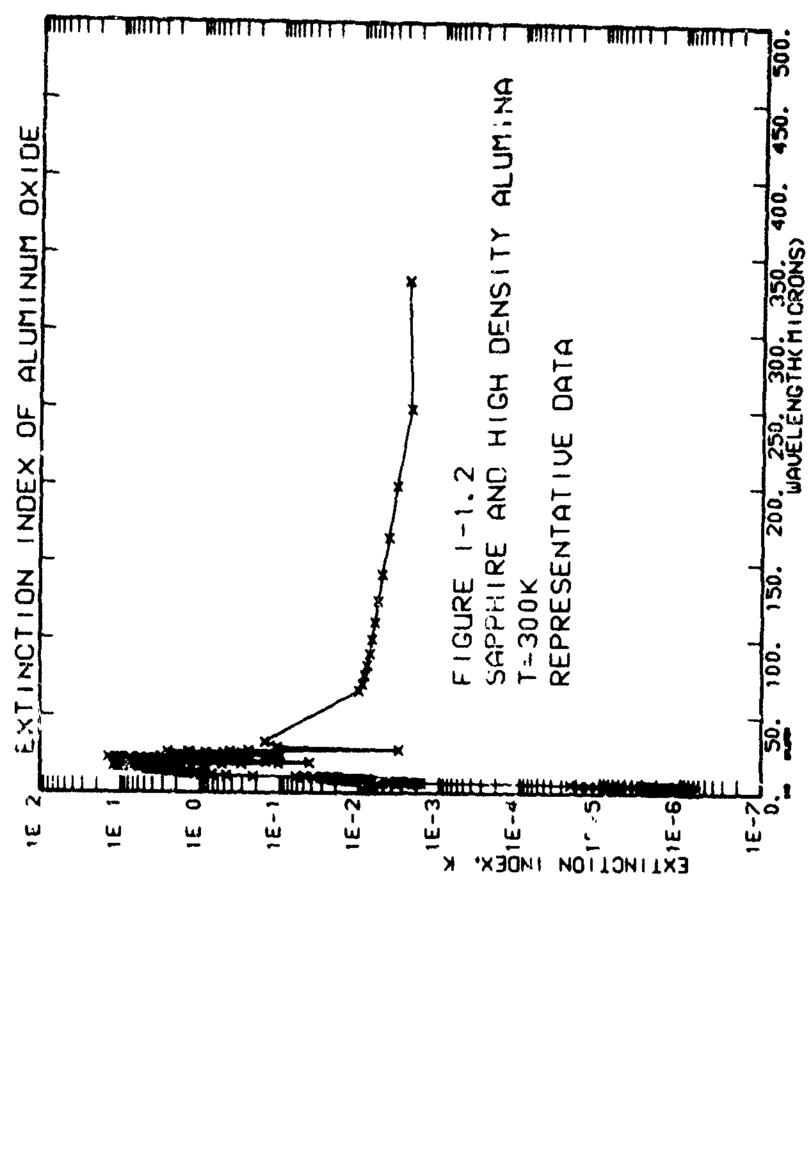
λ	k	λ	k	λ	k
2.052	6.530E-07	2.244	6.661E-07	2.381	6.783E-07
2.540	6.954E-07	2.694	7.031E-07	2.885	7.268E-07
3.092	7.524E-07	3.280	7.810E-07	3.444	8.095E-07
3.554	8.364E-07	3.658	8.727E-07	3.830	9.471E-07
3.948	1.014E-06	4.089	1.110E-06	4.230	1.218E-06
4.350	1.337E-06	4.491	1.502E-06	[illegible]	1.682E-06
4.741	1.895E-06	4.853	2.148E-06	4.929	2.336E-06
5.015	2.559E-06	5.081	2.795E-06	5.133	3.102E-06
5.171	3.709E-06	5.212	4.583E-06	5.256	5.859E-06
5.299	7.860E-06	5.346	1.084E-05	5.384	1.374E-05
5.434	1.813E-05	5.478	2.338E-05	6.728	1.717E-03
6.798	1.890E-03	6.855	2.028E-03	5.885	2.236E-03
6.941	2.781E-03	6.970	3.068E-03	7.024	3.409E-03
7.050	3.481E-03	7.080	3.332E-03	7.127	3.538E-03
7.244	4.247E-03	7.337	5.119E-03	7.438	6.039E-03
7.526	7.283E-03	7.559	7.607E-03	7.595	7.787E-03
7.633	7.376E-03	7.658	6.979E-03	7.685	[illegible]
7.729	7.714E-03	7.772	8.396E-03	7.834	[illegible]
7.859	8.614E-03	7.937	8.523E-03	8.009	[illegible]
8.050	9.115E-03	8.085	8.816E-03	8.125	8.273E-03
8.204	7.884E-03	8.232	8.003E-03	8.274	[illegible]
9.347	9.214E-03	8.406	9.801E-03	8.452	[illegible]
8.496	1.090E-02	8.522	1.152E-02	8.592	[illegible]
8.657	1.324E-02	8.761	1.304E-02	8.743	1.372E-02
8.825	1.498E-02	8.920	1.721E-02	8.988	1.841E-02
9.096	1.961E-02	9.128	1.930E-02	9.212	1.892E-02
9.266	1.873E-02	9.339	1.967E-02	9.399	2.092E-02
9.447	2.154E-02	9.598	2.189E-02	9.681	2.276E-02
9.946	2.648E-02	10.052	2.827E-02	10.140	2.856E-02
10.272	3.071E-02	10.438	3.747E-02	10.603	4.808E-02
10.758	6.327E-02	10.922	2.170E-01	11.186	4.701E-01
11.541	7.265E-01	11.869	9.665E-01	12.179	1.170E+00
12.510	1.407E+00	12.879	1.591E+00	13.292	1.798E+00
13.639	2.015E+00	14.008	2.235E+00	14.352	2.482E+00
14.630	2.712E+00	14.961	2.968E+00	15.168	[illegible]
15.305	3.402E+00	15.451	3.734E+00	15.551	[illegible]
15.612	4.408E+00	15.712	4.655E+00	15.772	4.247E+00
15.851	3.208E+00	15.908	2.919E+00	16.062	3.281E+00
16.413	4.406E+00	16.730	5.360E+00	16.845	5.869E+00
17.049	7.366E+00	17.274	9.451E+00	17.357	1.073E+01
17.440	1.251E+01	17.549	9.802E+00	17.652	5.588E+00
17.722	3.439E+00	17.806	2.002E+00	17.969	1.345E+00

Table I-1.2 (Continued)

λ	k	λ	k	λ	k
18.162	8.810E-01	18.474	5.358E-01	18.852	3.057E-01
19.403	1.052E-01	19.902	4.274E-02	20.302	1.512E-01
20.610	3.517E-01	20.860	8.876E-01	21.092	1.492E+00
21.335	2.400E+00	21.527	3.189E+00	21.736	3.810E+00
21.832	4.372E+00	22.060	5.638E+00	22.296	7.574E+00
22.330	9.603E+00	22.651	1.087E+01	22.832	1.437E+01
23.033	3.083E+00	23.143	1.742E+00	23.289	1.114E+00
23.578	6.443E-01	23.979	2.498E-01	24.431	1.052E-01
24.724	9.862E-02	25.185	2.959E-01	25.593	5.062E-01
25.818	8.514E-01	26.011	1.345E+00	26.150	2.590E+00
26.380	1.423E+00	26.716	4.274E-01	27.017	2.465E-01
28.179	3.287E-03	29.726	1.085E-01	33.213	1.578E-01
66.667	1.008E-02	71.429	9.095E-03	76.923	8.570E-03
83.333	7.938E-03	90.909	7.379E-03	100.000	6.923E-03
111.111	6.455E-03	125.000	5.769E-03	142.857	5.229E-03
166.657	4.377E-03	200.000	3.501E-03	250.000	2.387E-03
333.333	2.653E-03				


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE I-1.2
SAPPHIRE AND HIGH DENSITY ALUMINA
T=300K
REPRESENTATIVE DATA
EXTINCTION INDEX, K
WAVELENGTH(MICRONS)
1E 2
1E 1
1E 0
1E-1
1E-2
1E-3
1E-4
1E-5
1E-6
1E-7
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE I-1.2
SAPPHIRE AND HIGH DENSITY ALUMINA
T=300K
REPRESENTATIVE DATA
EXTINCTION INDEX, K
WAVELENGTH(MICRONS)
1E 2
1E 1
1E 0
1E-1
1E-2
1E-3
1E-4
1E-5
1E-6
1E-7
0.
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE I-1.2
SAPPHIRE AND HIGH DENSITY ALUMINA
T=300K
REPRESENTATIVE DATA
WAVELENGTH(MICRONS)
EXTINCTION INDEX, K

I-1.3 Spectral Emissivity, $\epsilon(\lambda)$ — Aluminum Oxide

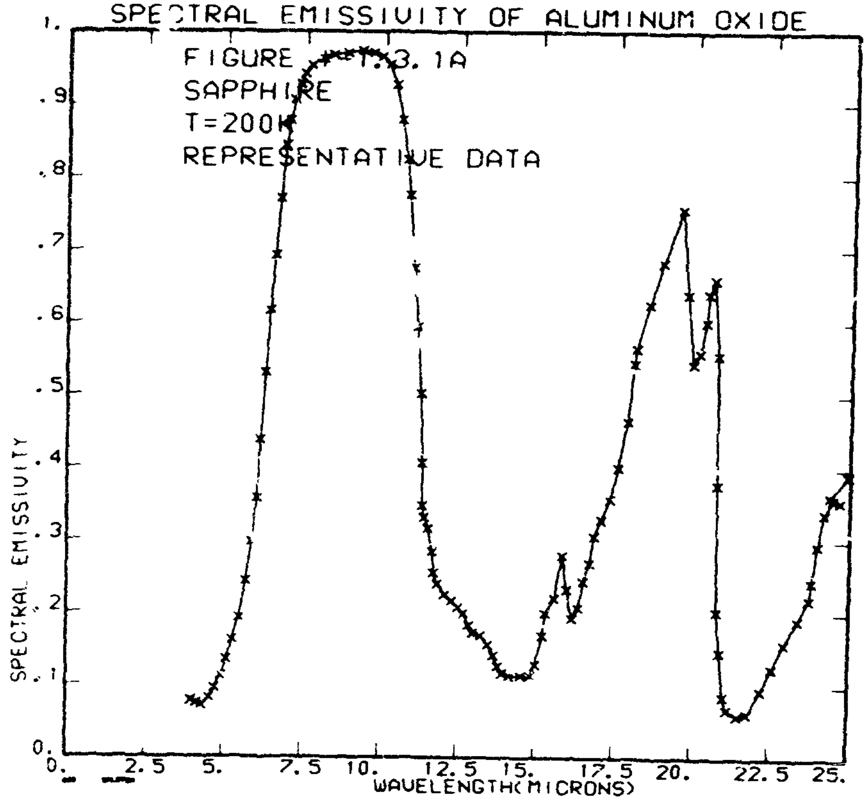
Representative curves for the spectral emissivity of bulk alumina, bulk sapphire, and powdered sapphire are presented in this section. Supplementary to this in Section III-1.3 are data for liquid alumina droplet emissivity and surface roughness effects on alumina emissivity. Additional data on emissivity are contained in Section I-1.4, where the reflectance data are summarized. Since Kirchhoff's law $\epsilon = 1-R$ applies only to the proper angular complements, a conversion of all reflectance to emissivity has not been made.

I-1.3.1 Bulk Al_2O_3

The bulk forms of Al_2O_3, sapphire (α - Al_2O_3) and alumina have different emissive properties, as shown in Figures I-1.3a, b, and c. All bulk Al_2O_3 shows a distinct emissivity maximum from approximately 4μ to 11μ, the onset of this peak shifting to shorter wavelengths as the sample temperature is increased. Representative data for sapphire are from Stierwalt (Ref. 1SE-16) over a temperature range 4.2°K to 200°K and a spectral range 1μ to 125μ; the data of Blau (Ref. 1SE-5) for 99 percent pure alumina over a temperature range of 800°K to 1300°K is taken to be representative of the pressed and sintered forms of Al_2O_3. A precision of 4 ± percent as claimed by Blau (Ref. 1SE-5) is taken to be representative of all data shown in Figures I-1.3.1 and I-1.3.2, although no explicit statement of precision is given by the other references shown. The effect of differences in sample surface preparation on Al_2O_3 emissivity has been studied by Richmond (Ref. 1SE-13) and has been found to be negligible below 14μ. The relatively minor effect of temperature can be seen in the data of Section III-1.3. Data from other researchers on many bulk forms of Al_2O_3 are included in Section III-1.3 in graphical and tabular form, where are also more detailed descriptions of the representative data.

Table I-1.3.1a Spectral Emissivity of Aluminum Oxide, T = 200°K — Representative Data

λ	ε	λ	ε	λ	ε
4.025	7.775E-02	4.202	7.350E-02	4.377	7.125E-02
4.510	8.150E-02	4.778	9.475E-02	4.973	1.115E-01
5.163	1.345E-01	5.342	1.605E-01	5.523	1.310E-01
5.744	2.425E-01	5.914	2.969E-01	6.068	3.570E-01
6.156	4.385E-01	6.311	5.312E-01	6.444	6.175E-01
6.581	6.938E-01	6.732	7.710E-01	6.896	8.448E-01
7.010	8.770E-01	7.145	9.066E-01	7.300	9.271E-01
7.448	9.414E-01	7.655	9.529E-01	8.025	9.621E-01
8.336	9.685E-01	8.780	9.719E-01	9.254	9.744E-01
9.611	9.711E-01	9.889	9.662E-01	10.135	9.545E-01
10.364	9.269E-01	10.556	8.788E-01	10.723	8.240E-01
10.830	7.760E-01	11.015	6.758E-01	11.142	5.947E-01
11.254	5.023E-01	11.331	4.060E-01	11.345	3.478E-01
11.415	3.312E-01	11.523	3.161E-01	11.674	2.844E-01
11.747	2.547E-01	11.868	2.396E-01	12.095	2.243E-01
12.342	2.166E-01	12.533	2.077E-01	12.709	1.995E-01
12.877	1.825E-01	13.036	1.710E-01	13.297	1.673E-01
13.520	1.532E-01	13.710	1.410E-01	13.843	1.268E-01
13.977	1.168E-01	14.199	1.125E-01	14.590	1.135E-01
14.896	1.138E-01	15.036	1.280E-01	15.258	1.675E-01
15.343	1.990E-01	15.614	2.202E-01	15.867	2.795E-01
16.007	2.322E-01	16.181	1.920E-01	16.386	2.072E-01
16.545	2.430E-01	16.728	2.683E-01	16.866	3.066E-01
17.093	3.294E-01	17.350	3.575E-01	17.611	4.010E-01
17.897	4.650E-01	18.089	5.443E-01	18.144	5.650E-01
18.540	6.208E-01	18.951	6.835E-01	19.565	7.565E-01
19.752	6.408E-01	19.970	5.433E-01	20.157	5.594E-01
20.358	6.610E-01	20.437	6.415E-01	20.616	6.500E-01
20.753	5.564E-01	20.790	3.780E-01	20.803	2.033E-01
20.947	1.475E-01	21.048	8.600E-02	21.174	6.800E-02
21.540	5.925E-02	21.840	6.325E-02	22.270	9.425E-02
22.621	1.250E-01	22.997	1.580E-01	23.416	1.910E-01
23.749	2.202E-01	23.827	2.440E-01	24.007	2.949E-01
24.217	3.389E-01	24.473	3.591E-01	24.701	3.555E-01
24.385	3.627E-01	24.955	3.923E-01	25.396	4.924E-01
25.653	5.267E-01	26.276	5.738E-01	27.316	6.135E-01
28.447	6.388E-01	30.426	6.630E-01	32.668	6.767E-01
34.959	6.812E-01	37.484	6.835E-01	40.496	6.835E-01
44.669	6.835E-01				


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE I-1.3.1A
SAPPHIRE
T=200K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

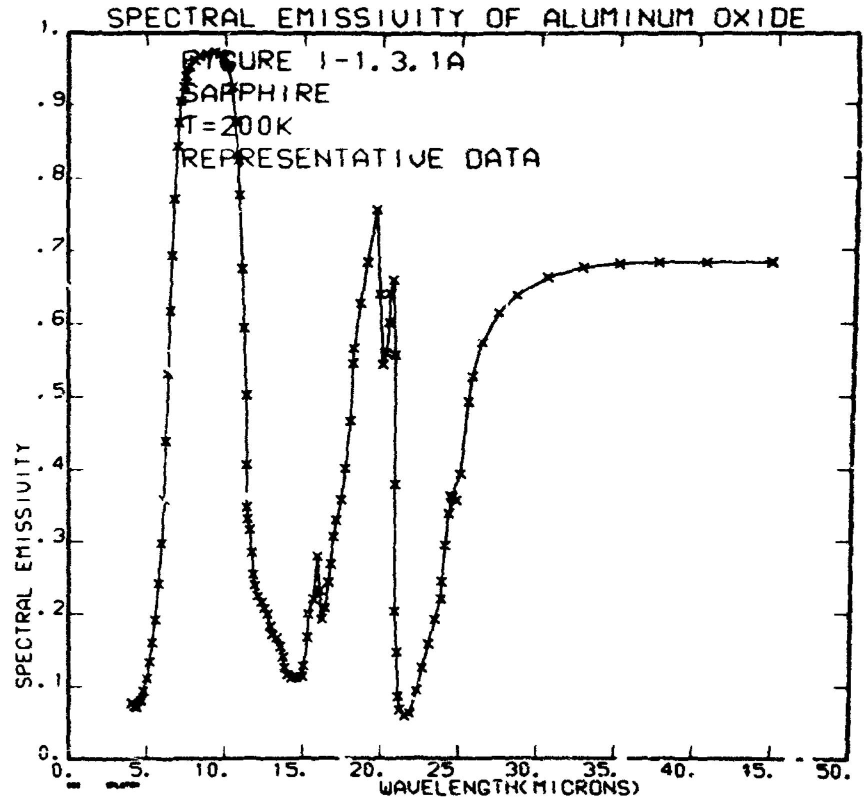
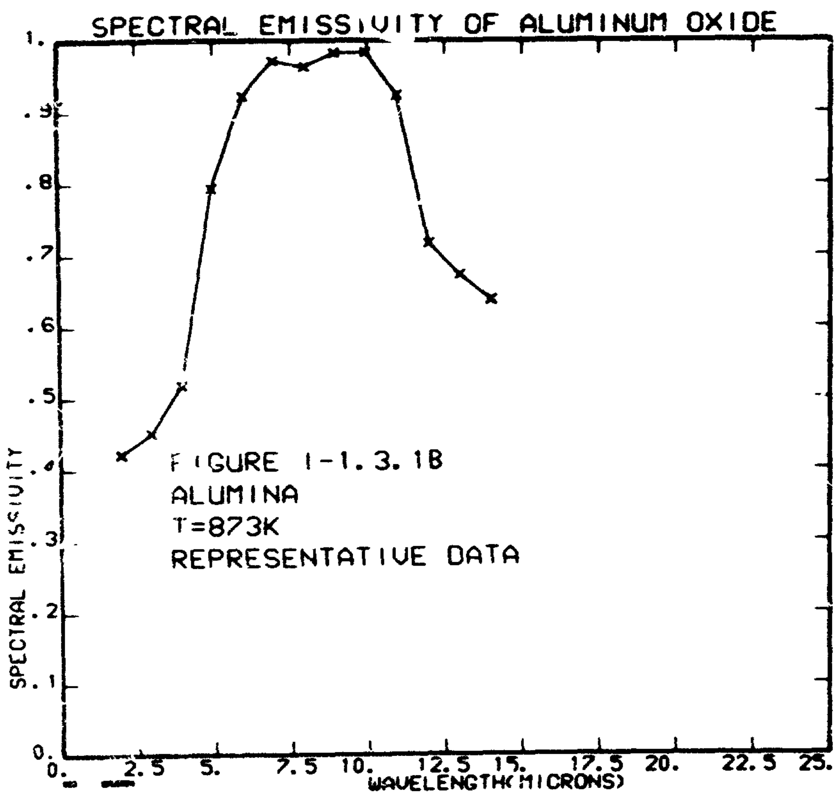

SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE I-1.3.1A
SAPPHIRE
T=200K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.

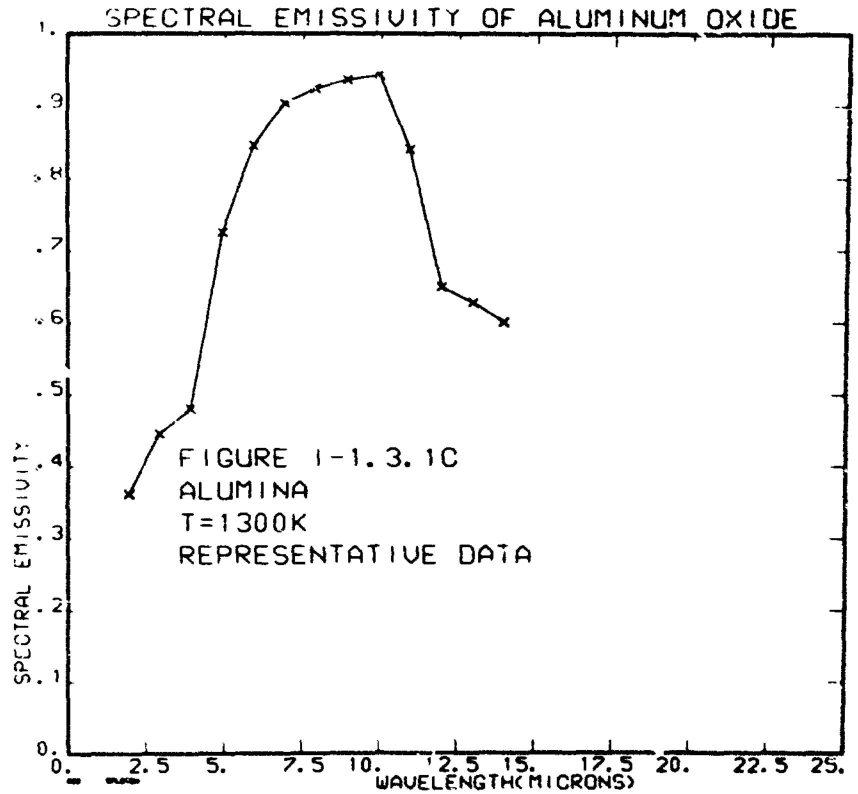
Table I-1.3.1b Spectral Emissivity of Alumina, $T=873^{\circ}K$ — Representative Data

λ	ε	λ	ε	λ	ε	λ	ε
1.974	.422	2.967	.453	3.967	.520	4.970	.735
5.975	.923	6.957	.972	7.975	.964	8.942	.983
9.901	.954	10.971	.924	11.984	.717	12.985	.673
14.011	.639						

Table I-1.3.1c Spectral Emissivity of Alumina, $T = 1373^{\circ}K$ — Representative Data

λ	ε	λ	ε	λ	ε	λ	ε
1.903	.563	2.937	.445	3.926	.482	4.941	.726
5.942	.846	6.932	.966	7.909	.925	8.931	.937
9.949	.944	10.935	.642	11.972	.650	12.974	.630
13.953	.601						


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE I-1.3.1B
ALUMINA
T=873K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE I-1.3.1C
ALUMINA
T=1300K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.

I-1.3.2 Powde :d Aluminum Oxide

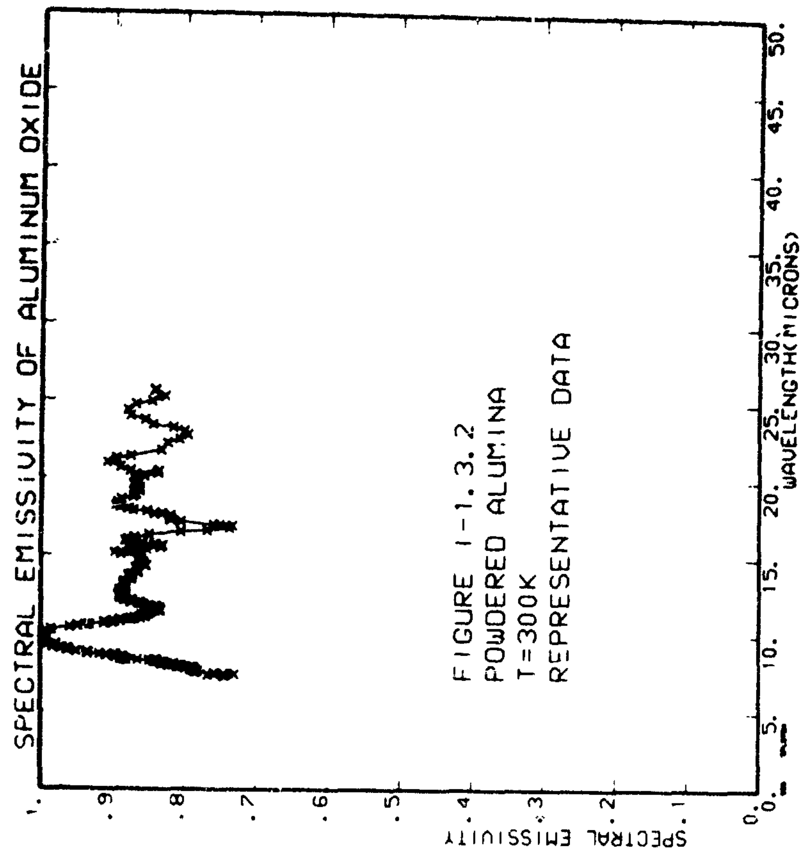
The representative spectral emissivity of powdered Al_2O_3 over a particle size range of 0.06 · 30 μ and a temperature of 300°K is shown in Figure I-1.3.2. The values of $\epsilon(\lambda)$ reported by Aronson (Ref. 1SE-2) and S:reed (Ref. 1SE-17) are much higher for $\lambda > 12\mu$ than the bulk materials, but do show the decrease at 11μ from a plateau starting at approximately 4μ. The sharp peak occuring at 3μ is due to water contamination of the sample and is not present in the high temperature data. The complete set of particle emissivity data is contained in Section III-1.3. The representative curve is for 9 WCA alumina particles at 300°K as measured by Aronson (Ref. 1SE-2).

Table I-1.3.2 Representative Data, Alumina Particles, T = 300^{o}K

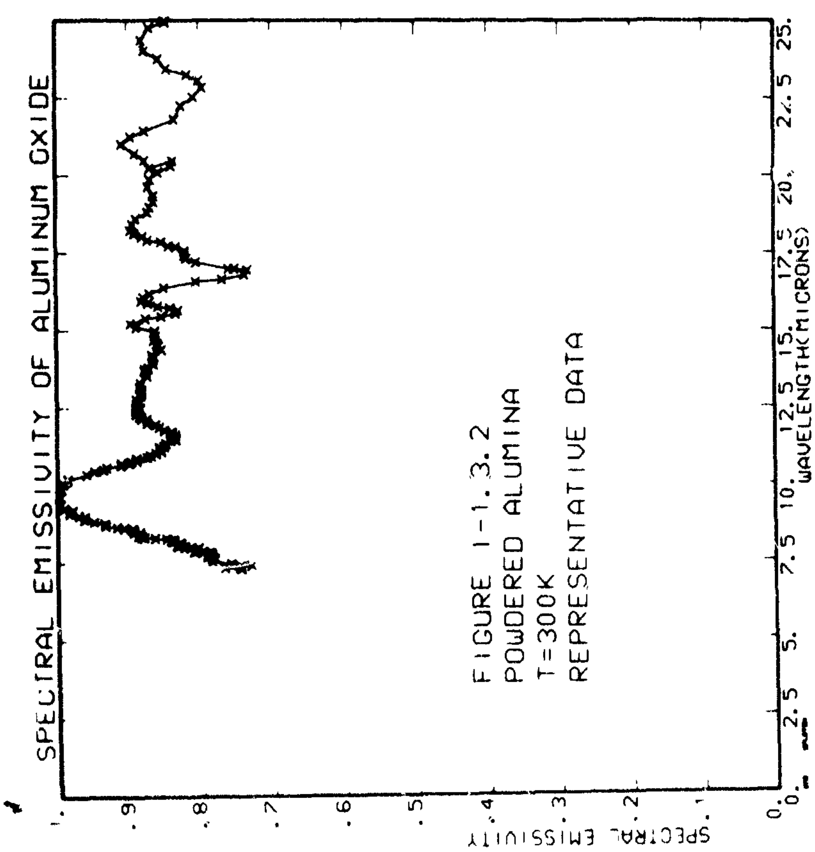
λ	ε	λ	ε	λ	ε
7.330	7.441E-01	7.371	7.676E-01	7.398	7.451E-01
7.433	7.304E-01	7.482	7.587E-01	7.549	7.856E-01
7.633	7.817E-01	7.672	7.841E-01	7.705	7.913E-01
7.727	7.861E-01	7.756	7.876E-01	7.778	7.911E-01
7.805	7.859E-01	7.831	7.896E-01	7.856	7.983E-01
7.831	8.106E-01	7.914	8.081E-01	7.981	8.042E-01
8.014	8.153E-01	8.042	8.239E-01	8.068	8.326E-01
8.097	8.329E-01	8.118	8.291E-01	8.172	8.291E-01
8.201	8.395E-01	8.233	8.425E-01	8.261	8.387E-01
8.289	8.437E-01	8.315	8.640E-01	8.341	8.793E-01
8.369	8.839E-01	8.394	8.887E-01	8.437	8.869E-01
8.408	8.855E-01	8.518	8.941E-01	8.577	8.956E-01
8.634	8.966E-01	8.634	9.081E-01	8.672	9.182E-01
8.716	9.345E-01	8.775	9.357E-01	8.834	9.503E-01
8.908	9.641E-01	8.979	9.620E-01	9.043	9.715E-01
9.117	9.64[illegible]E-01	9.201	9.796E-01	9.265	9.912E-01
9.401	9.964E-01	9.636	9.960E-01	9.919	9.959E-01
10.050	9.921E-01	10.203	9.867E-01	10.354	9.604E-01
10.454	9.492E-01	10.502	9.368E-01	10.590	9.321E-01
10.605	9.123E-01	10.709	9.115E-01	10.728	9.007E-01
10.787	8.975E-01	10.819	8.891E-01	10.877	8.891E-01
10.920	8.745E-01	10.965	8.696E-01	11.039	8.610E-01
11.114	8.541E-01	11.179	8.550E-01	11.226	8.570E-01
11.270	8.501E-01	11.359	8.487E-01	11.456	8.418E-01
11.479	8.339E-01	11.546	8.353E-01	11.625	8.353E-01
11.689	8.402E-01	11.737	8.406E-01	11.777	8.503E-01
11.882	8.573E-01	11.950	8.625E-01	12.012	8.739E-01
12.123	8.745E-01	12.169	8.822E-01	12.235	8.855E-01
12.308	8.904E-01	12.433	8.908E-01	12.497	8.847E-01
12.555	8.892E-01	12.664	8.879E-01	12.710	8.852E-01
12.735	8.896E-01	12.874	8.820E-01	12.979	8.817E-01
13.031	8.81[illegible]E-01	13.184	8.849E-01	13.302	8.839E-01
13.328	8.729E-01	13.657	8.758E-01	13.725	8.771E-01
13.780	8.724E-01	13.904	8.647E-01	14.084	8.652E-01
14.199	8.674E-01	14.374	8.531E-01	14.501	8.575E-01
14.590	8.590E-01	14.683	8.634E-01	14.842	8.615E-01
14.994	8.624E-01	15.122	8.884E-01	15.235	8.971E-01
15.373	8.755E-01	15.452	8.531E-01	15.558	8.336E-01
15.653	8.304E-01	15.737	8.415E-01	15.774	8.580E-01
15.892	8.719E-01	15.964	8.822E-01	16.070	8.783E-01
16.135	8.639E-01	16.394	8.497E-01	16.584	8.059E-01
16.569	7.681E-01	16.861	7.374E-01	16.950	7.336E-01

Table I-1.3.2 Representative Data, Alumina Particles, T = 300°K (continued)

λ	ε	λ	ε	λ	ε
17.010	7.512E-01	17.018	7.597E-01	17.220	8.059E-01
17.329	8.190E-01	17.432	8.218E-01	17.584	8.202E-01
17.709	8.323E-01	17.733	8.425E-01	17.852	8.524E-01
17.900	8.7[illegible]0E-01	18.026	8.783E-01	18.123	8.899E-01
18.232	8.950E-01	18.426	8.936E-01	18.599	8.886E-01
18.806	8.711E-01	18.99[illegible]	8.584E-01	19.168	8.630E-01
19.355	8.634E-01	19.624	8.713E-01	19.836	8.681E-01
20.118	8.550E-01	20.320	8.382E-01	20.474	8.365E-01
20.241	8.681E-01	20.492	8.751E-01	20.709	8.896E-01
21.016	9.031E-01	21.255	8.955E-01	21.443	8.758E-01
21.804	8.331E-01	22.260	8.247E-01	22.525	8.076E-01
22.340	7.955E-01	23.056	8.008E-01	23.272	8.163E-01
23.446	8.444E-01	23.759	8.556E-01	24.018	8.756E-01
24.355	8.737E-01	24.756	8.081E-01	24.963	8.469E-01
25.270	8.291E-01	25.651	8.422E-01		



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1-1.3.2
POWDERED ALUMINA
T=300K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1-1.3.2
POWDERED ALUMINA
T=300K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)

I-1.4 Total Normal Emissivity, ϵ(T) — Aluminum Oxide

The total emissivities of bulk alumina and sapphire have been measured in the literature for temperatures ranging from 63^{o}K to 1800^{o}K. The representative curve for alumina data, constructed by fitting a third order polynomial to data from References 1TE-4 and 1TE-5 is shown in Table I-1.4 and Figure I-1.4. ϵ(T) = 0.77 at low temperatures, then goes through an apparent minimum of about 0.37 at 1660^{o}K. No experimental error is quoted for these data.

ϵ (T) for sapphire is given in Section III-1.4 in tabulated form in Ref. 1TE-2 and 1TE-6, and appears to be less than the alumina emissivity over the range of temperatues covered, 200^{o}K to 1273^{o}K.

One reference (1TE-3) gives ϵ(T) for rocket exhaust particles from T = 1389^{o}K to 2222^{o}K. This is presented in Section III-1.4.

Table I-1.4 Bulk Alumina Total Emittance — Representative Data

T(°K)	ε(T)	T(°K)	ε(T)	T(°K)	ε(T)
0.000	.7722	900.000	.5359	1780.000	.376[illegible]
20.000	.7705	920.000	.5291	1800.000	.3781
40.000	.7692	940.000	.5224	1820.000	.3806
60.000	.7673	960.000	.5157	1840.000	.3834
80.000	.7651	980.000	.5090	1860.000	.3866
100.000	.7626	1000.000	.5024	1880.000	.3902
120.000	.7600	1020.000	.4959	1900.000	.3942
140.000	.7578	1040.000	.4895	1920.000	.3986
160.000	.7539	1060.000	.4831	1940.000	.4034
180.000	.75[illegible]5	1080.000	.4769	1960.000	.4087
200.000	.7458	1100.000	.4708	1980.000	.4143
220.000	.7430	1120.000	.4647	2000.000	.4204
240.000	.7389	1140.000	.4588	2020.000	.4269
260.000	.7347	1160.000	.4530	2040.000	.4339
280.000	.7303	1180.000	.4474	2060.000	.4413
300.000	.7256	1200.000	.4419	2080.000	.4492
320.000	.7208	1220.000	.4365	2100.000	.4575
340.000	.7158	1240.000	.4313		
360.000	.7107	1260.000	.4263		
380.000	.7054	1280.000	.4214		
400.000	.6999	1300.000	.4167		
420.000	.6943	1320.000	.4122		
440.000	.6886	1340.000	.4079		
460.000	.6827	1360.000	.4038		
480.000	.6767	1380.000	.3999		
500.000	.6707	1400.000	.3962		
520.000	.6644	1420.000	.3927		
540.000	.6581	1440.000	.3894		
560.000	.6517	1460.000	.3864		
580.000	.6453	1480.000	.3836		
600.000	.6387	1500.000	.3811		
620.000	.6321	1520.000	.3788		
640.000	.6254	1540.000	.3768		
660.000	.6186	1560.000	.3751		
680.000	.6118	1580.000	.3736		
700.000	.6050	1600.000	.3725		
720.000	.5981	1620.000	.3716		
740.000	.5912	1640.000	.3710		
760.000	.5843	1660.000	.3708		
780.000	.5774	1680.000	.3708		
800.000	.5704	1700.000	.3712		
820.000	.5635	1720.000	.3719		
840.000	.5566	1740.000	.3729		
860.000	.5497	1760.000	.3743		
[illegible]	.5428				

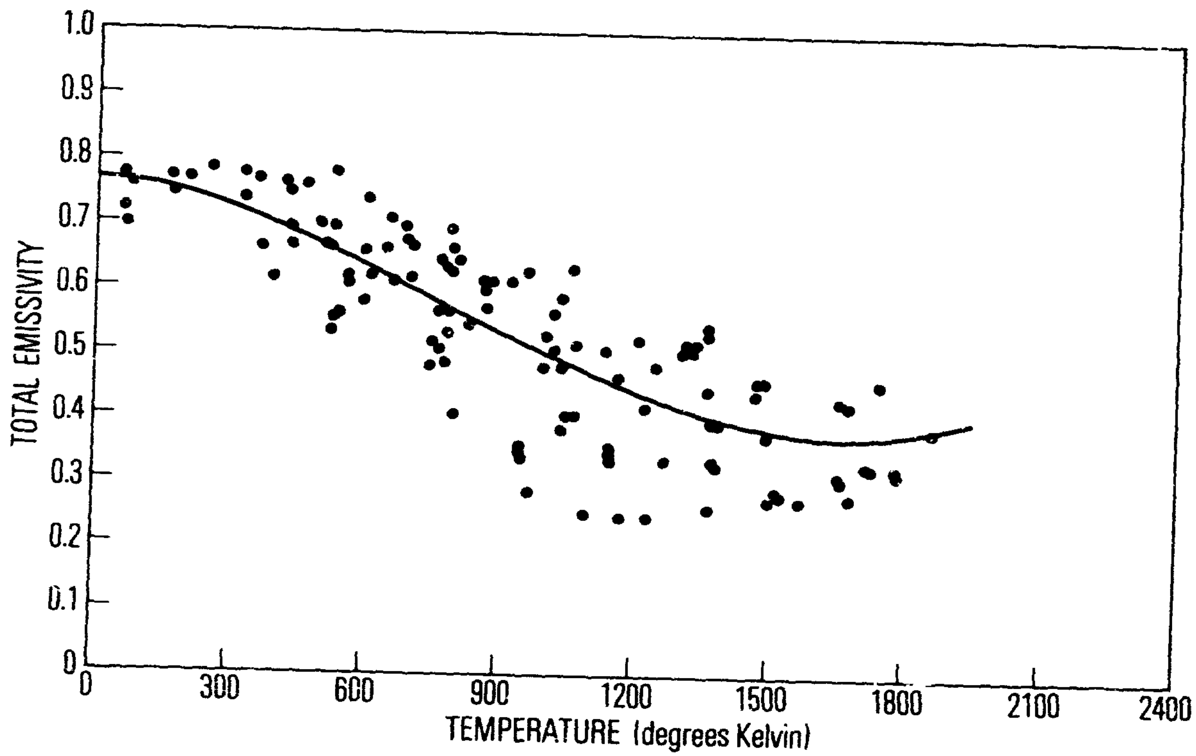


Figure I-1.4 The Total Normal Emissivity of Aluminum Oxide as a Function of Temperature

I-1.5. Reflectivity - Aluminum Oxide

Reflectivity data for sapphire, bulk alumina, alumina powders and films at 300°K are tabulated in Section III. Representative curves for sapphire, bulk alumina, and alumina powder are presented here. Since the reflectivity of a sample is highly dependent upon surface conditions, the representative curve should be interpreted only in a relative sense. No attempt has been made to normalize the curves used as representative reflectivities.

I-1.5.1. Sapphire

The 300°K data of Aronson (Ref. 1R-3) and Barker Ref. 1R-4) have been taken as representative and plotted together in Figure I-1.5.1. Reflection maxima are seen to occur at approximately 14.5μ, 17.5μ, 21.7μ, 23.0μ, 27 to 29μ, and 52μ. Lattice parameter information deduced from these and other data are presented in Section I-1.7.

I-1.5.2 Bulk Alumina

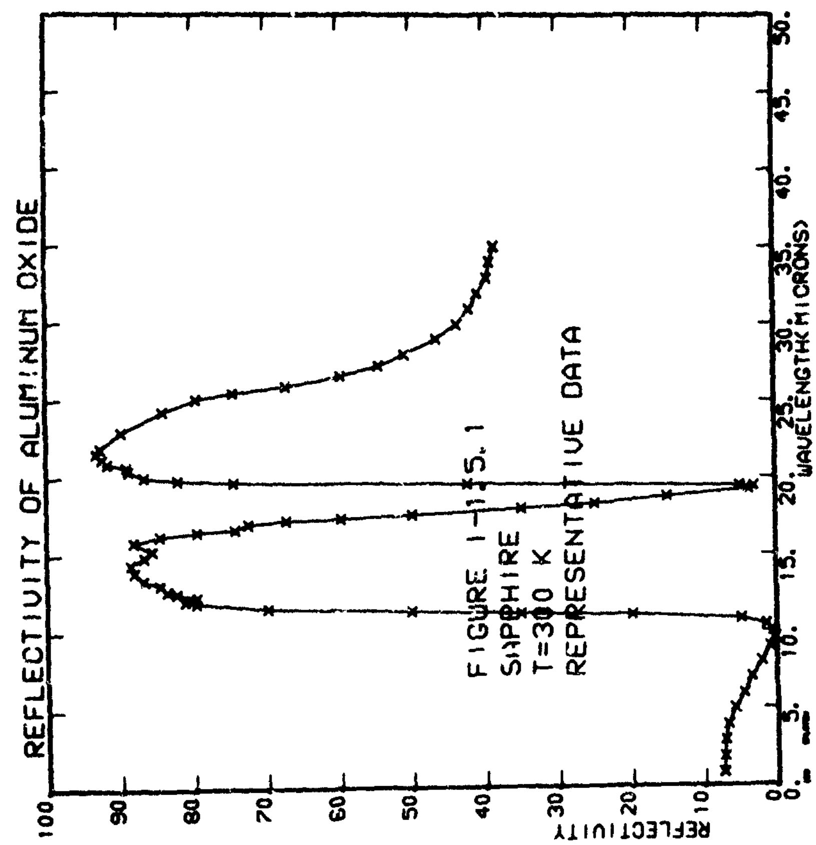
The reflectance of bulk alumina at short wavelengths has been found to be much higher than sapphire reflectance. The data for $\lambda > 9\mu$ are similar to sapphire. The data of Clark (Ref. IR-6) and Harris (Ref. IR-18) are plotted as representative data in Figures I-1.5.2 and tabulated in Table I-1.5.2.

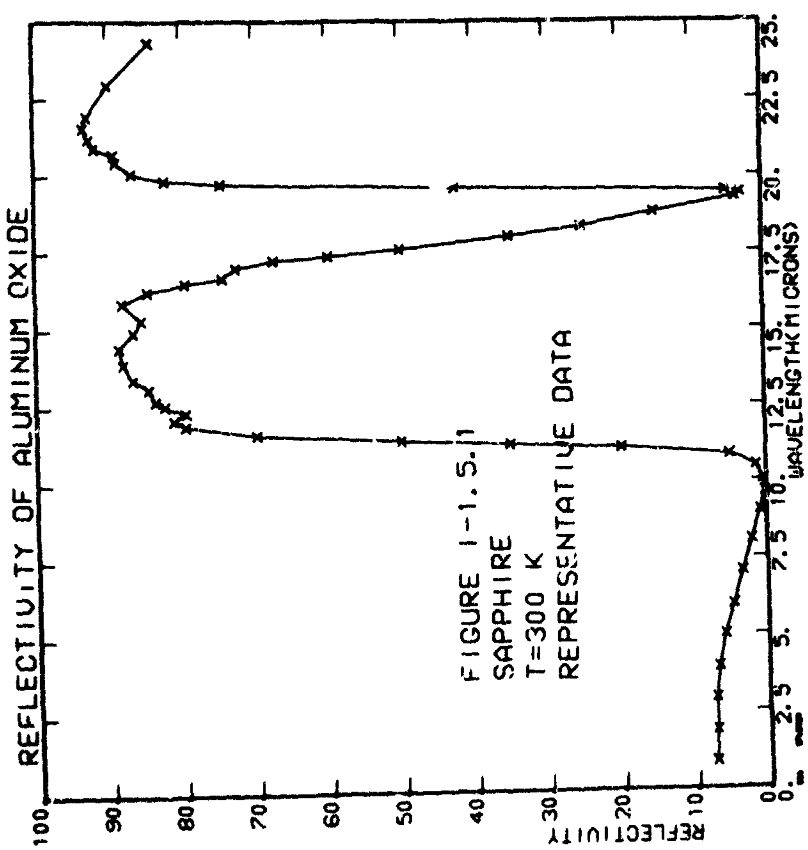
I-1.5.3 Alumina Powder

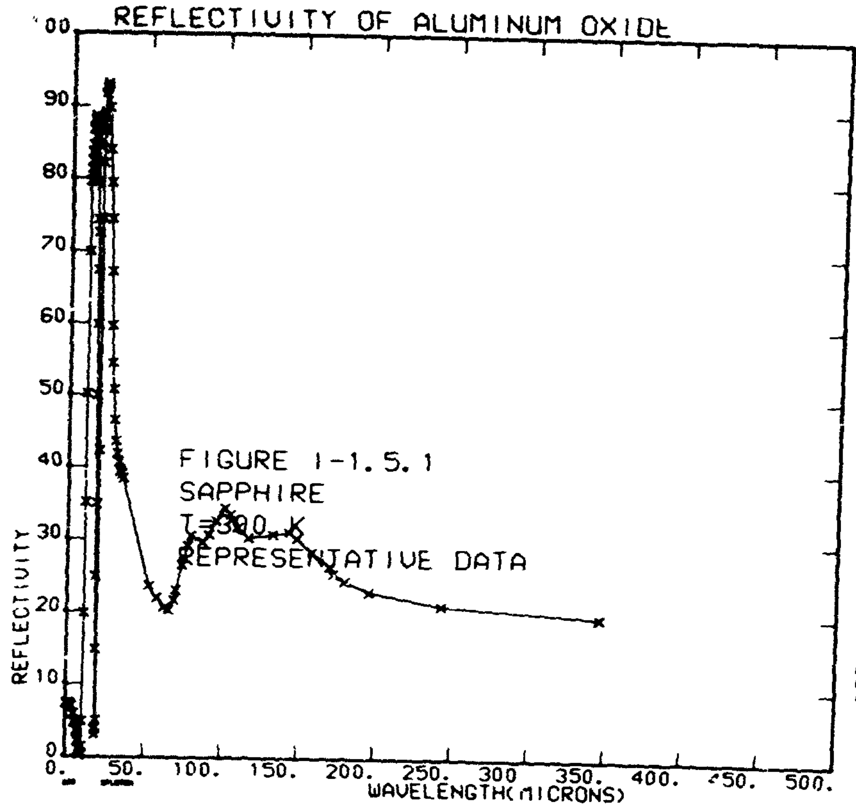
The reflectivity for 3.5μ mean diameter alumina platelets at 300°K from 7μ to 30μ is shown in Figure I-1.5.3. These data are from Aronson (Ref. 1R-1) and data for particle sizes up to 100μ are plotted and tabulated in Section III-1.5. The small peak between 10μ and 12μ has been observed for spinel alumina by Levy (Ref. 1R-10). The gross features of the alumina powder reflectance match those of the sapphire.

Table I-1.5.1 Sapphire - Representative Data

λ	R	λ	R	λ	R
.890	7.418E+00	1.905	7.319E+00	2.957	7.191E+00
3.948	6.879E+00	5.006	5.901E+00	5.996	4.695E+00
7.054	3.516E+00	8.082	2.170E+00	9.037	9.362E-01
9.627	2.837E-01	10.044	4.397E-01	10.476	1.433E+00
10.894	4.936E+00	11.104	1.988E+01	11.224	3.511E+01
11.367	5.019E+01	11.577	6.996E+01	11.895	7.977E+01
12.074	8.134E+01	12.322	7.960E+01	12.550	8.247E+01
12.710	8.372E+01	13.119	8.468E+01	13.411	8.682E+01
13.905	8.811E+01	14.442	8.865E+01	14.942	8.675E+01
15.327	8.566E+01	15.883	8.820E+01	16.248	8.466E+01
16.501	7.958E+01	16.685	7.431E+01	17.015	7.255E+01
17.268	6.734E+01	17.388	5.987E+01	17.603	4.991E+01
18.015	3.491E+01	18.338	2.492E+01	18.776	1.489E+01
19.289	3.745E+00	19.411	3.064E+00	19.484	5.078E+00
19.609	4.235E+01	19.735	7.455E+01	19.854	8.222E+01
20.087	8.673E+01	20.466	8.898E+01	20.722	8.913E+01
20.917	9.177E+01	21.211	9.244E+01	21.552	9.327E+01
21.925	9.270E+01	22.556	8.989E+01	24.327	8.416E+01
25.117	7.952E+01	25.533	7.459E+01	25.964	6.724E+01
26.623	5.973E+01	27.279	5.450E+01	27.999	5.082E+01
29.042	4.655E+01	29.977	4.367E+01	30.983	4.198E+01
31.981	4.074E+01	32.978	3.949E+01	34.014	3.901E+01
35.015	3.840E+01	52.480	2.363E+01	57.878	2.207E+01
62.684	2.061E+01	65.676	2.034E+01	66.473	2.172E+01
70.142	2.318E+01	74.354	2.657E+01	77.764	2.927E+01
79.819	3.067E+01	87.183	2.974E+01	91.298	3.071E+01
95.525	3.262E+01	101.010	3.441E+01	105.263	3.352E+01
109.589	3.173E+01	116.505	3.037E+01	132.450	3.083E+01
143.369	3.111E+01	148.331	3.032E+01	158.103	2.848E+01
170.213	2.646E+01	172.414	2.542E+01	179.910	2.447E+01
195.759	2.307E+01	243.408	2.110E+01	346.821	1.967E+01
621.762	1.900E+01	621.762	1.900E+01		


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE I-1.5.1
SAPPHIRE
T=300 K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE I-1.5.1
SAPPHIRE
T=300 K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE I-1.5.1
SAPPHIRE
T=300 K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300 350. 400. 450. 500.
0 10 20 30 40 50 60 70 80 90 100

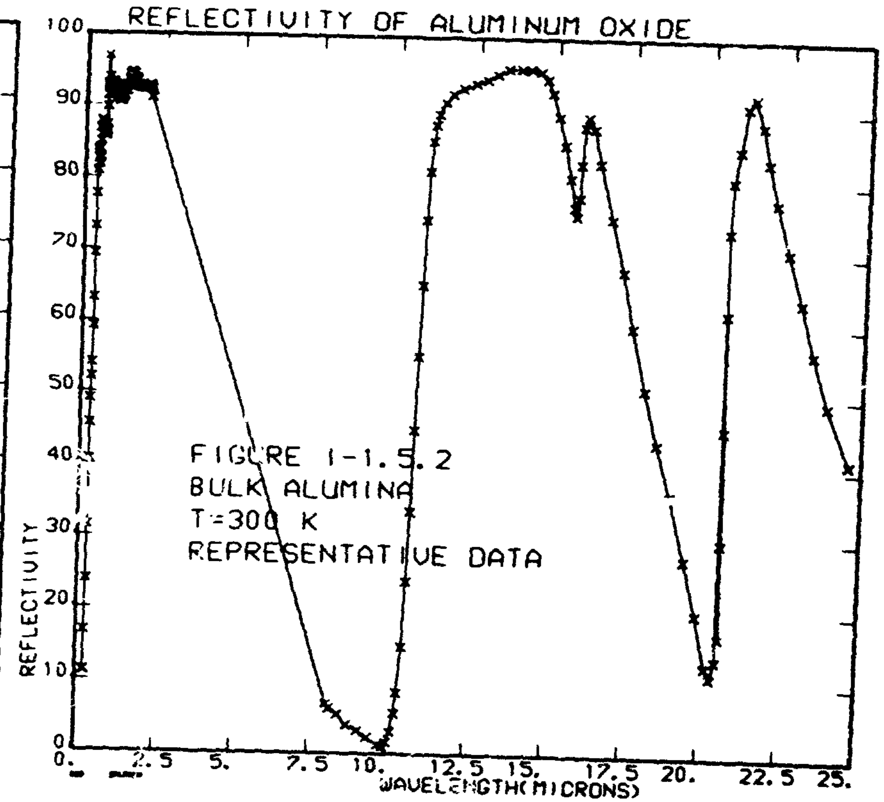
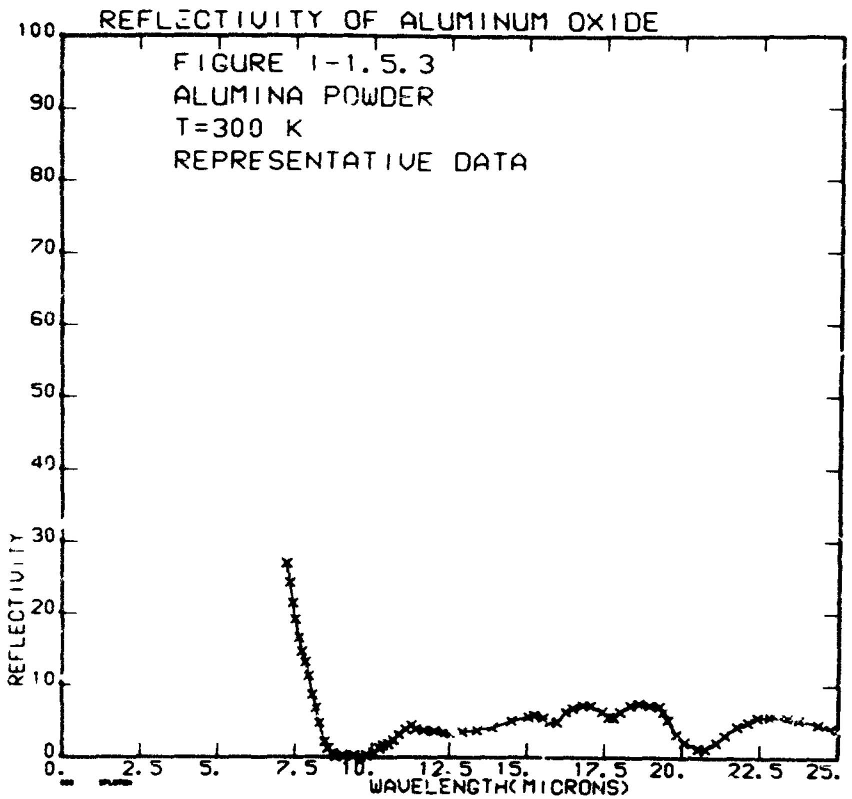

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE I-1.5.2
BULK ALUMINA
T=300 K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

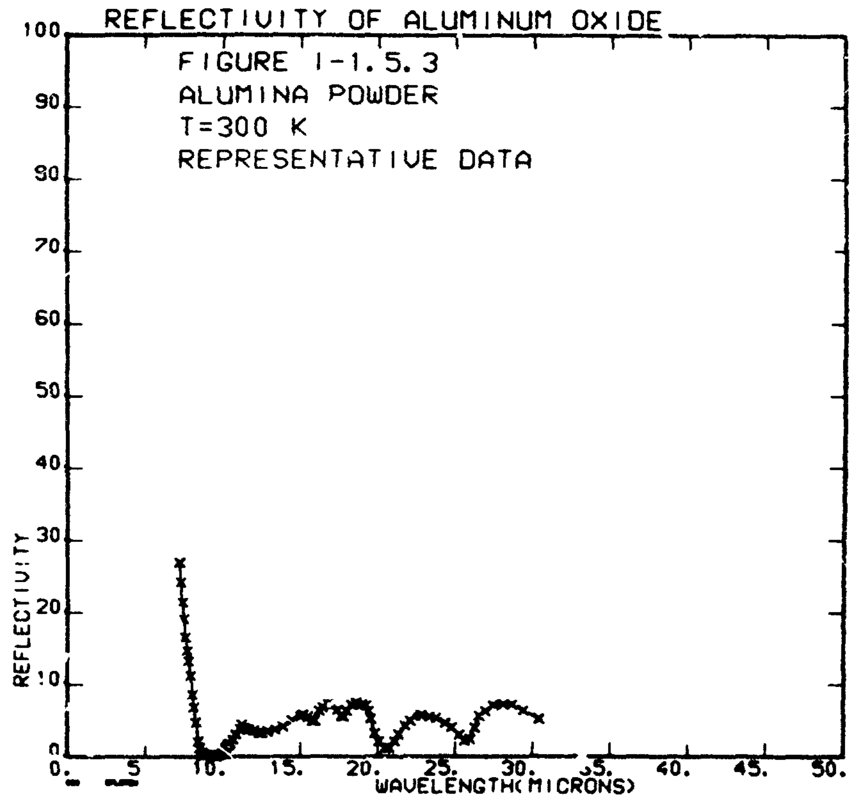
Table I-1.5.2 Bulk Alumina Reflectivity - Representative Data

λ	R	λ	R	λ	R	λ	R
.259	1.121E+01	.271	1.682E+01	.281	2.395E+01	.292	3.144E+01
.299	3.431E+01	.304	4.063E+01	.311	4.566E+01	.313	4.901E+01
.333	5.217E+01	.343	5.414E+01	.350	5.929E+01	.356	6.323E+01
.364	6.945E+01	.375	7.325E+01	.390	7.778E+01	.409	8.094E+01
.429	8.408E+01	.439	8.365E+01	.447	8.266E+01	.455	8.183E+01
.468	8.257E+01	.483	8.508E+01	.495	8.682E+01	.510	8.793E+01
.529	8.765E+01	.555	8.682E+01	.564	8.637E+01	.612	8.595E+01
.632	8.583E+01	.651	8.640E+01	.665	8.736E+01	.675	8.982E+01
.683	9.297E+01	.691	9.691E+01	.699	9.399E+01	.703	9.141E+01
.714	9.133E+01	.740	9.246E+01	.768	9.307E+01	.786	9.319E+01
.813	9.324E+01	.844	9.299E+01	.879	9.260E+01	.910	9.231E+01
.942	9.224E+01	.971	9.261E+01	.995	9.238E+01	1.018	9.156E+01
1.041	9.114E+01	1.061	9.065E+01	1.104	9.070E+01	1.136	9.100E+01
1.181	9.131E+01	1.228	9.200E+01	1.290	9.270E+01	1.323	9.368E+01
1.364	9.435E+01	1.402	9.475E+01	1.441	9.445E+01	1.491	9.431E+01
1.533	9.384E+01	1.572	9.345E+01	1.605	9.277E+01	1.665	9.272E+01
1.715	9.253E+01	1.769	9.243E+01	1.837	9.244E+01	1.905	9.244E+01
1.957	9.255E+01	1.996	9.280E+01	2.030	9.268E+01	2.062	9.222E+01
2.094	9.114E+01	8.074	6.831E+00	8.173	6.208E+00	8.467	5.429E+00
8.759	4.065E+00	9.102	3.260E+00	9.441	2.377E+00	9.794	1.286E+00
9.941	1.169E+00	10.057	1.675E+00	10.172	3.117E+00	10.273	5.623E+00
10.347	8.571E+00	10.454	1.496E+01	10.538	2.401E+01	10.612	3.371E+01
10.689	4.312E+01	10.758	5.556E+01	10.831	6.558E+01	10.904	7.479E+01
10.991	8.142E+01	11.055	8.564E+01	11.130	8.798E+01	11.220	8.944E+01
11.410	9.103E+01	11.637	9.211E+01	11.965	9.305E+01	12.362	9.374E+01
12.715	9.426E+01	13.033	9.506E+01	13.376	9.582E+01	13.781	9.583E+01
14.032	9.533E+01	14.403	9.552E+01	14.627	9.443E+01	14.816	9.258E+01
15.045	8.938E+01	15.265	8.532E+01	15.458	8.073E+01	15.602	7.677E+01
15.633	7.557E+01	15.754	7.812E+01	15.821	8.279E+01	15.890	8.798E+01
15.934	8.934E+01	16.174	8.770E+01	16.406	8.280E+01	16.831	7.512E+01
17.238	6.789E+01	17.587	5.999E+01	18.024	5.116E+01	18.454	4.363E+01
18.929	3.640E+01	19.446	2.751E+01	19.849	2.009E+01	20.214	1.287E+01
20.350	1.137E+01	20.543	1.377E+01	20.614	6.202E+01	20.614	2.991E+01
20.614	4.577E+01	20.614	1.693E+01	20.614	7.352E+01	20.673	8.062E+01
20.802	8.491E+01	21.367	9.095E+01	21.283	9.221E+01	21.560	8.838E+01
21.789	8.322E+01	22.091	7.762E+01	22.520	7.070E+01	22.948	6.378E+01
23.373	5.053E+01	23.894	4.931E+01	24.602	4.138E+01		

Table I-1.5.3   Powdered Aluminum Oxide Reflectivity — Representative Data

λ	R	λ	R	λ	R
7.225	2.092E+01	7.325	2.422E+01	7.443	2.143E+01
7.519	1.569E+01	7.624	1.657E+01	7.728	1.475E+01
7.838	1.329E+01	7.902	1.122E+01	8.094	8.636E+00
8.138	6.886E+00	8.317	4.752E+00	8.477	2.169E+00
8.535	1.198E+00	8.723	4.959E-01	8.842	1.653E-01
9.034	2.688E-01	9.434	2.036E-01	9.637	4.132E-02
9.323	2.533E-01	10.067	5.155E-01	10.265	1.260E+00
10.306	1.612E+00	10.528	1.850E+00	10.712	2.293E+00
10.895	3.140E+00	11.114	3.034E+00	11.283	4.421E+00
11.430	3.907E+00	11.693	3.740E+00	12.025	3.616E+00
12.350	3.306E+00	12.545	3.366E+00	12.930	3.533E+00
13.403	3.645E+00	13.915	4.132E+00	14.509	5.021E+00
15.004	5.040E+00	15.231	5.626E+00	15.534	5.517E+00
15.795	4.897E+00	15.973	4.938E+00	16.255	5.384E+00
16.475	5.01[illegible]E+00	16.808	7.273E+00	17.059	7.190E+00
17.440	5.403E+00	17.051	5.662E+00	17.810	5.517E+00
18.013	6.302E+00	18.323	7.211E+00	18.598	7.521E+00
18.957	7.252E+00	19.292	7.128E+00	19.409	5.343E+00
19.551	5.209E+00	19.625	3.282E+00	20.033	2.107E+00
20.540	1.240E+00	20.759	1.219E+00	21.106	2.107E+00
21.383	3.140E+00	21.734	4.339E+00	22.138	4.979E+00
22.437	5.040E+00	22.839	5.754E+00	23.386	5.517E+00
23.735	5.31[illegible]E+00	24.388	4.059E+00	24.788	4.050E+00
25.243	3.017E+00	25.622	2.231E+00	25.959	2.459E+00
26.270	4.035E+00	26.559	5.620E+00	26.965	5.302E+00
27.475	7.139E+00	28.100	[illegible].273E+00	28.563	7.231E+00
29.414	6.435E+00	30.437	5.289E+00		


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE I-1.5.3
ALUMINA POWDER
T=300 K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
0
10
20
30
40
50
60
70
80
90
100


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE I-1.5.3
ALUMINA POWDER
T=300 K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)
0.
5
10.
15.
20.
25.
30.
35.
40.
45.
50.
0
10
20
30
40
50
60
70
80
90
100

I-1.6. Transmittance - Aluminum Oxide

The transmittance of Al_2O_3 is shown in Tables I-1.6a through I-1.6e for T = $300^{o}K$. The transmittance is a weak function of temperature, and variations with T that occur over some spectral ranges are tabulated in Section III-1.6. The unnormalized transmittances of various thicknesses of sapphire and alumina powder shown in the figures are taken from Oppenheim (Ref. 1T-17), Piriou (Ref. 1T-19), White (Ref. 1T-22), Dorsey (Ref. 1T-1) and Loewenstein (Ref. 1T-9). The structure observed in the optical properties of alumina is tabulated in terms of normal lattice frequencies and absorption bands in Section I-1.7.

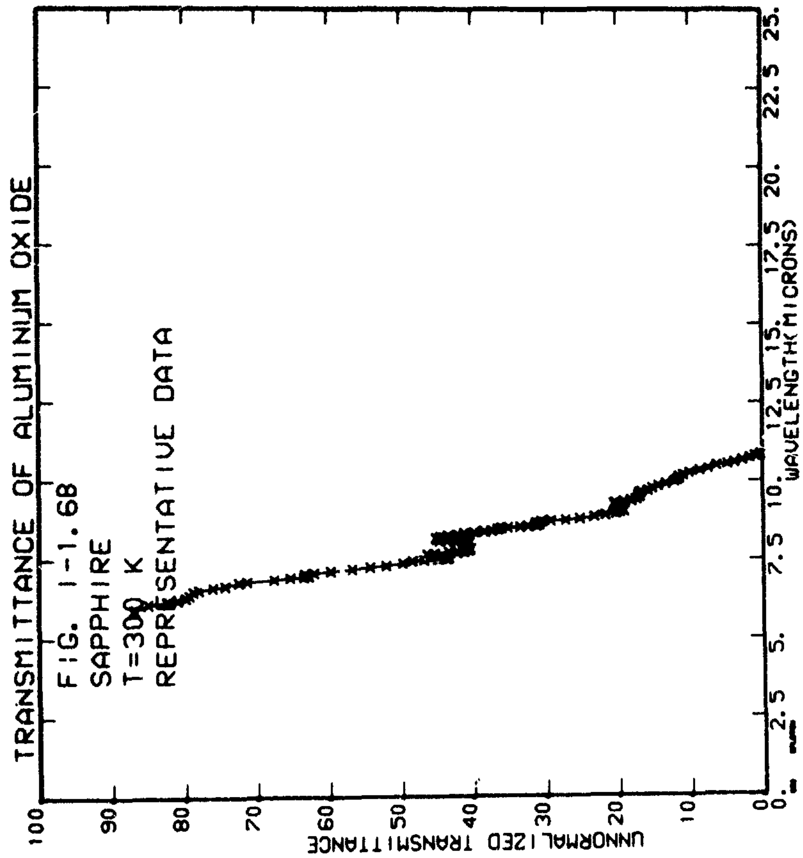
Table I-1.6 Aluminum Oxide Transmittance — Representative Data

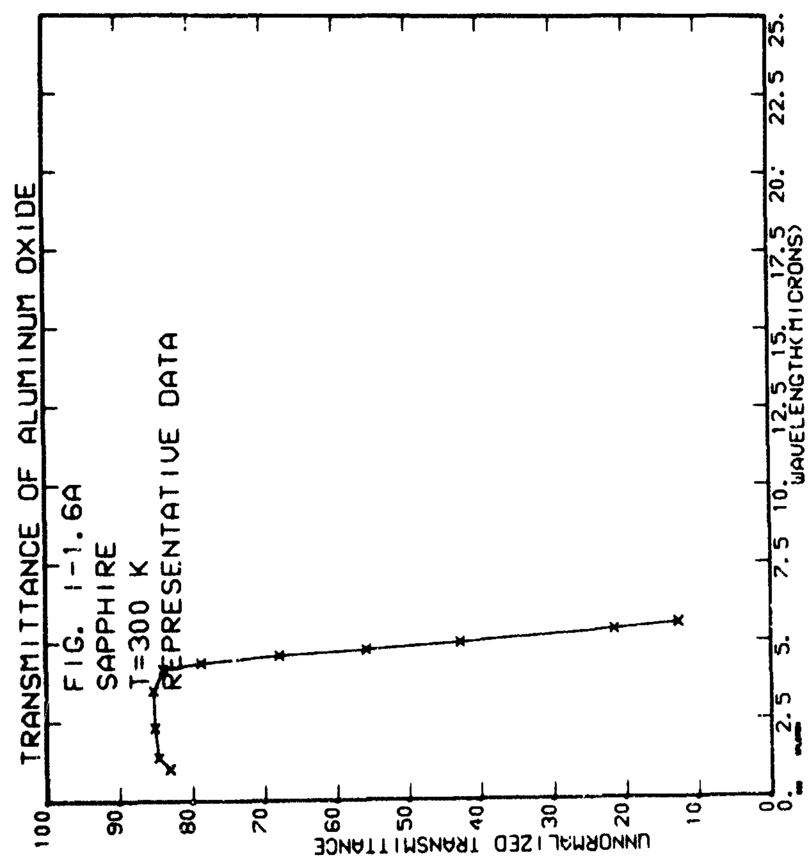
a. Sapphire of unspecified thickness (from Ref. 1T-17).

λ	T	λ	T	λ	T	λ	T
1.029	8.305E+01	1.397	8.466E+01	2.338	8.310E+01	3.513	8.538E+01
4.189	8.389E+01	4.374	7.871E+01	4.598	6.784E+01	4.792	5.579E+01
4.998	4.280E+01	5.409	2.151E+01	5.619	1.267E+01		

b. Sapphire, T = 0.062 mm (from Ref. 1T-19).

λ	T	λ	T	λ	T	λ	T
6.102	8.513E+01	6.198	8.250E+01	6.239	8.109E+01	5.943	8.699E+01
6.391	7.941E+01	6.505	7.896E+01	6.566	7.814E+01	6.310	7.997E+01
6.693	7.441E+01	6.778	7.262E+01	6.815	7.147E+01	6.625	7.612E+01
6.923	6.548E+01	6.959	6.350E+01	6.989	6.281E+01	6.880	6.765E+01
7.081	6.213E+01	7.135	5.988E+01	7.283	5.684E+01	7.049	6.343E+01
7.321	5.210E+01	7.380	4.988E+01	7.458	4.846E+01	7.265	5.436E+01
7.507	4.489E+01	7.535	4.376E+01	7.571	4.345E+01	7.478	4.688E+01
7.622	4.569E+01	7.651	4.648E+01	7.690	4.549E+01	7.596	4.433E+01
7.746	4.221E+01	7.759	4.124E+01	7.804	4.060E+01	7.724	4.345E+01
8.019	4.070E+01	8.054	4.056E+01	8.075	4.134E+01	7.909	4.114E+01
8.106	4.376E+01	8.120	4.471E+01	8.152	4.509E+01	8.086	4.244E+01
8.221	4.461E+01	8.268	4.365E+01	8.296	4.227E+01	8.182	4.521E+01
8.357	3.988E+01	8.384	3.842E+01	8.415	3.745E+01	8.336	4.136E+01
8.488	3.610E+01	8.514	3.523E+01	8.540	3.359E+01	8.448	3.666E+01
8.580	3.135E+01	8.604	3.092E+01	8.635	3.109E+01	8.558	3.248E+01
8.701	3.059E+01	8.730	2.932E+01	8.772	2.727E+01	8.671	3.138E+01
8.864	2.338E+01	8.910	2.179E+01	8.963	2.038E+01	8.815	2.520E+01
9.044	1.913E+01	9.107	1.962E+01	9.151	2.014E+01	8.999	1.970E+01
9.234	1.916E+01	9.251	2.068E+01	9.282	2.029E+01	9.206	2.046E+01
9.408	1.739E+01	9.482	1.701E+01	9.579	1.703E+01	9.364	1.810E+01
9.676	1.583E+01	9.749	1.523E+01	9.839	1.442E+01	9.625	1.672E+01
9.979	1.216E+01	10.028	1.173E+01	10.073	1.140E+01	9.915	1.330E+01
10.195	1.096E+01	10.261	1.002E+01	10.335	6.636E+00	10.136	1.157E+01
10.491	6.389E+00	10.541	4.859E+00	10.593	3.877E+00	10.397	7.504E+00
10.738	1.780E+00	10.795	1.082E+00	10.828	3.830E-01	10.668	2.779E+00


TRANSMITTANCE OF ALUMINUM OXIDE
FIG. I-1.6B
SAPPHIRE
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
100 90 80 70 60 50 40 30 20 10 0
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
WAVELENGTH(MICRONS)

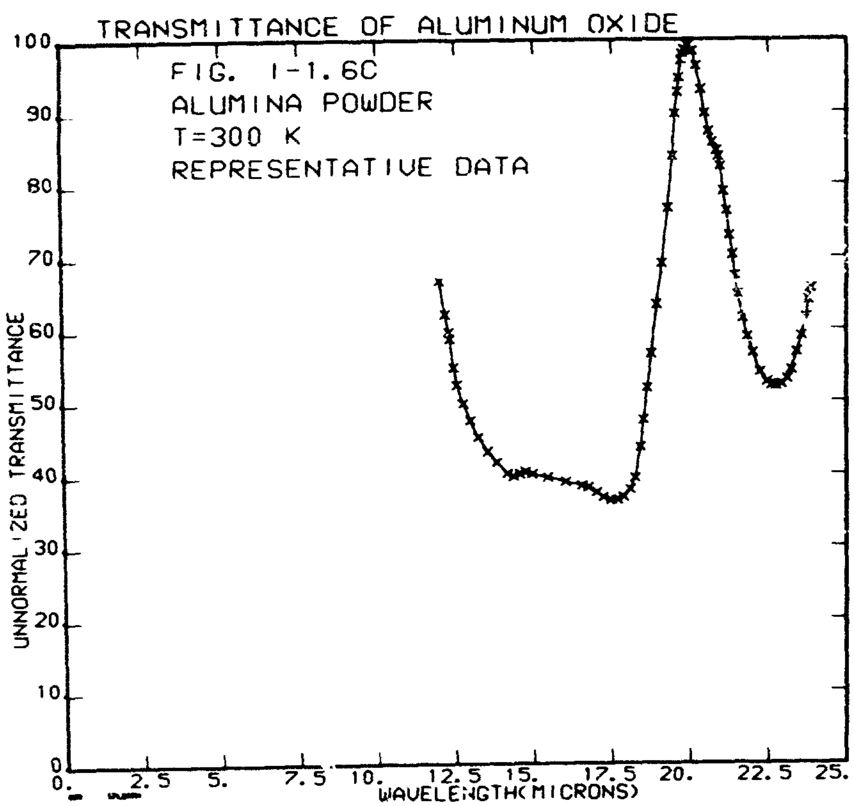

TRANSMITTANCE OF ALUMINUM OXIDE
FIG. I-1.6A
SAPPHIRE
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
100 90 80 70 60 50 40 30 20 10 0
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
WAVELENGTH(MICRONS)

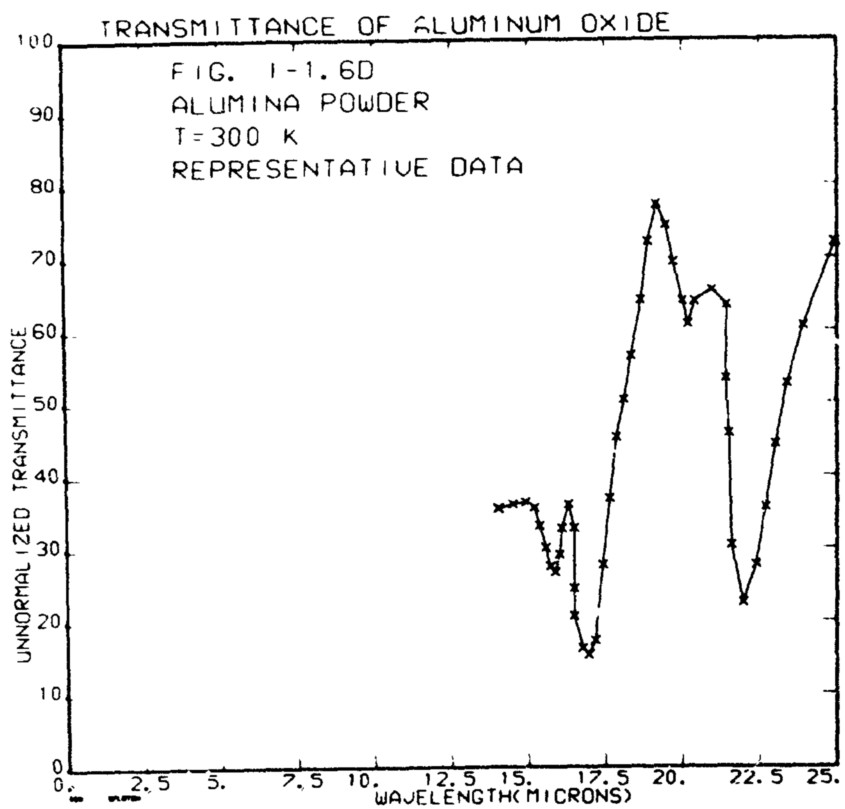
c. Alumina Powder

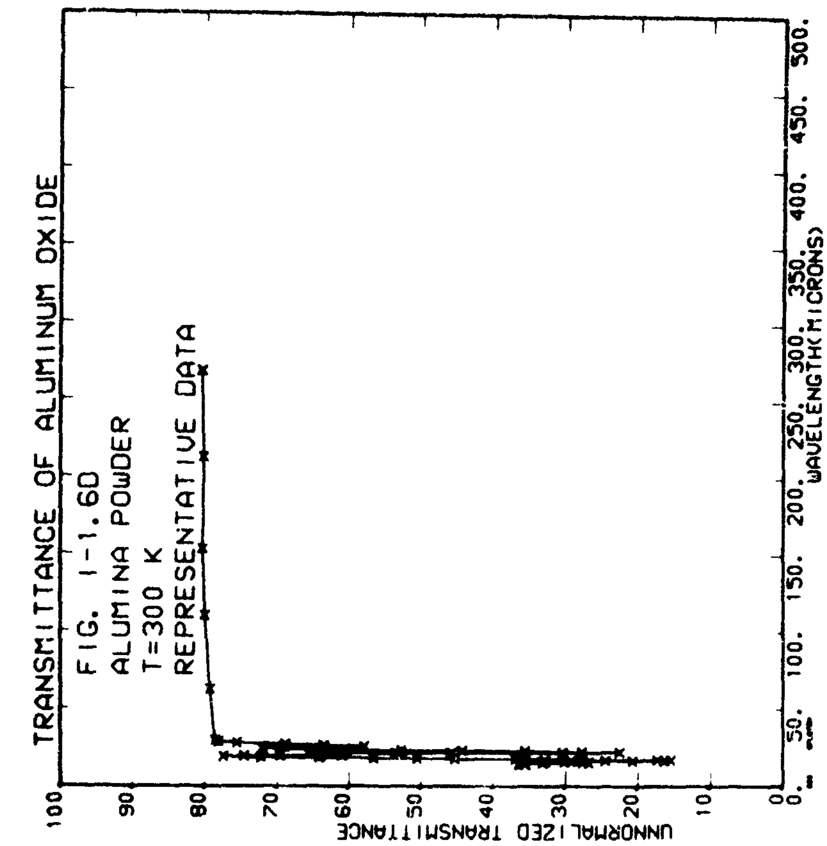
λ	T	λ	T	λ	T	λ	T
12.000	7.256E+01	12.019	6.689E+01	12.193	6.225E+01	12.307	5.985E+01
12.341	5.809E+01	12.455	5.492E+01	12.556	5.251E+01	12.761	4.989E+01
12.984	4.757E+01	13.247	4.523E+01	13.536	4.329E+01	13.835	4.171E+01
14.155	4.026E+01	14.355	3.984E+01	14.556	4.318E+01	14.733	4.041E+01
14.955	4.017E+01	15.463	3.966E+01	16.035	3.902E+01	16.560	3.848E+01
16.767	3.822E+01	17.024	3.752E+01	17.243	3.683E+01	17.483	3.646E+01
17.677	3.047E+01	17.884	3.689E+01	18.106	3.793E+01	18.253	3.951E+01
18.430	4.373E+01	18.545	4.758E+01	18.554	5.194E+01	18.792	5.667E+01
18.963	6.340E+01	19.126	5.919E+01	19.308	7.084E+01	19.463	8.403E+01
19.546	8.930E+01	19.619	9.288E+01	19.672	9.473E+01	19.724	9.724E+01
19.762	9.816E+01	19.829	9.872E+01	19.969	9.921E+01	20.078	9.853E+01
20.231	9.042E+01	20.358	9.311E+01	20.486	8.989E+01	20.621	8.728E+01
20.742	8.382E+01	20.859	8.474E+01	20.911	8.397E+01	20.984	8.252E+01
21.090	7.954E+01	21.190	7.644E+01	21.291	7.296E+01	21.394	7.036E+01
21.472	6.743E+01	21.567	6.478E+01	21.716	6.150E+01	21.864	5.898E+01
22.033	5.076E+01	22.266	5.412E+01	22.482	5.271E+01	22.631	5.229E+01
22.795	5.213E+01	22.968	5.231E+01	23.142	5.316E+01	23.265	5.446E+01
23.439	5.022E+01	23.590	5.902E+01	23.728	6.152E+01	23.821	6.393E+01
23.891	6.551E+01						

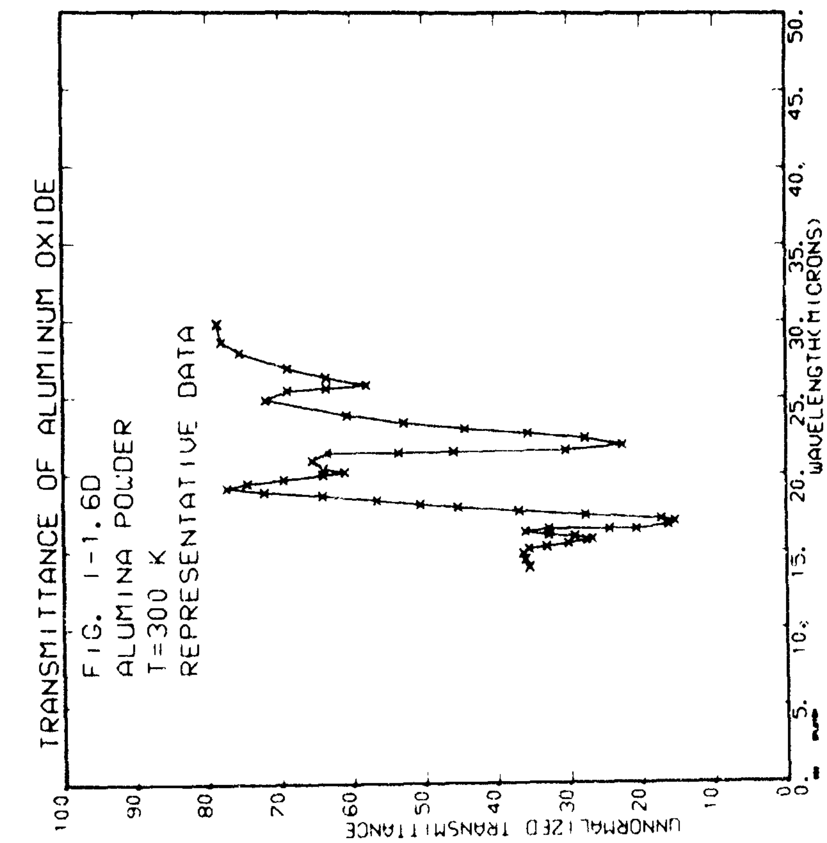
d. Alumina Powder

λ	T	λ	T	λ	T
14.037	3.353E+01	14.517	3.609E+01	14.949	3.648E+01
15.209	3.560E+01	15.376	3.315E+01	15.585	3.009E+01
15.747	2.757E+01	15.878	2.676E+01	16.037	2.922E+01
16.105	3.280E+01	16.315	3.609E+01	16.503	3.280E+01
16.522	2.448E+01	16.522	2.073E+01	16.773	1.638E+01
16.936	1.547E+01	17.190	1.733E+01	17.430	2.778E+01
17.671	3.690E+01	17.897	4.532E+01	18.123	5.058E+01
18.361	5.558E+01	18.677	6.415E+01	18.899	7.222E+01
19.159	7.745E+01	19.476	7.450E+01	19.723	6.955E+01
20.033	6.401E+01	20.209	6.096E+01	20.340	6.391E+01
20.985	6.552E+01	21.464	6.342E+01	21.447	5.342E+01
21.526	4.584E+01	21.601	3.048E+01	21.990	2.255E+01
22.432	2.774E+01	22.712	3.567E+01	23.040	4.434E+01
23.416	5.272E+01	23.933	6.065E+01	24.931	7.204E+01
25.495	6.392E+01	25.673	6.352E+01	25.875	5.791E+01
26.362	6.356E+01	26.981	6.889E+01	27.967	7.555E+01
28.651	7.815E+01	29.874	7.860E+01	62.488	7.934E+01
110.262	6.001E+01	53.163	8.032E+01	212.658	8.029E+01
268.815	6.043E+01				


TRANSMITTANCE OF ALUMINUM OXIDE
FIG. I-1.6C
ALUMINA POWDER
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

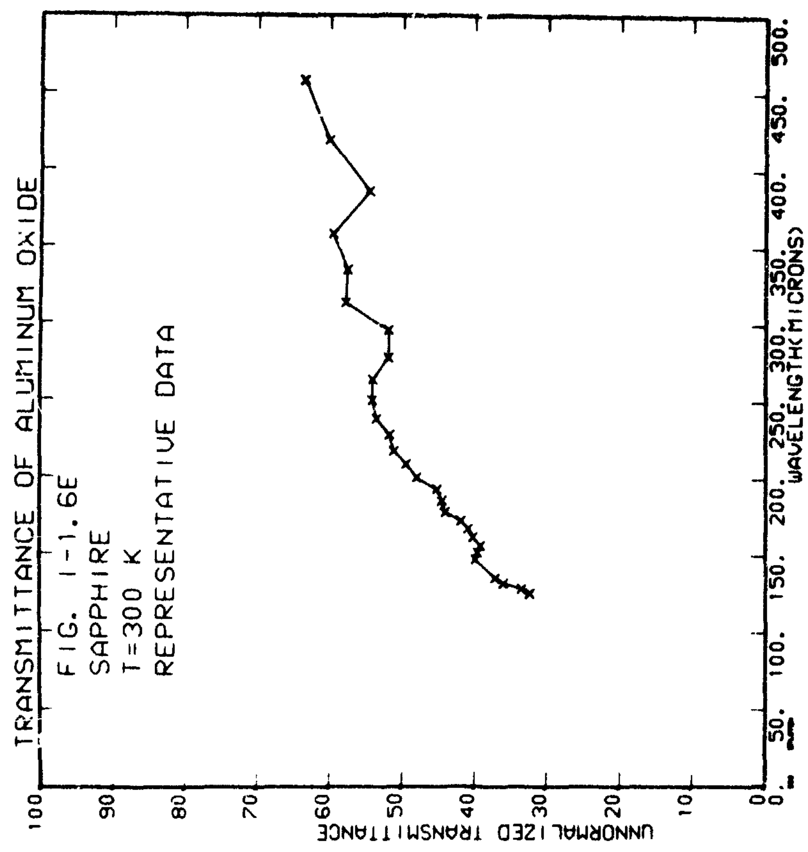

TRANSMITTANCE OF ALUMINUM OXIDE
FIG. I-1.6D
ALUMINA POWDER
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100


TRANSMITTANCE OF ALUMINUM OXIDE
FIG. I-1.6D
ALUMINA POWDER
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0 10 20 30 40 50 60 70 80 90 100


TRANSMITTANCE OF ALUMINUM OXIDE
FIG. I-1.6D
ALUMINA POWDER
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

e. Sapphire

λ	T	λ	T	λ	T
1000.000	6.725E+01	845.631	6.552E+01	725.640	5.697E+01
628.549	5.938E+01	562.283	6.725E+01	505.790	6.087E+01
458.250	6.353E+01	418.968	6.000E+01	386.260	5.459E+01
358.369	5.955E+01	335.279	5.763E+01	313.619	5.789E+01
295.834	5.196E+01	277.596	5.195E+01	263.485	5.405E+01
250.000	5.410E+01	238.144	5.350E+01	227.807	5.172E+01
217.252	5.118E+01	208.724	4.957E+01	200.419	4.800E+01
192.804	4.510E+01	185.409	4.442E+01	177.800	4.405E+01
172.417	4.194E+01	167.266	4.092E+01	161.582	4.024E+01
156.371	3.916E+01	151.615	3.959E+01	146.978	3.988E+01
135.230	3.717E+01	131.757	3.605E+01	128.315	3.351E+01
125.106	3.237E+01				



TRANSMITTANCE OF ALUMINUM OXIDE
FIG. I-1.6E
SAPPHIRE
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
100
90
80
70
60
50
40
30
20
10
0
0.
50.
100.
150.
200.
250.
300.
350.
400.
450.
500.
WAVELENGTH(MICRONS)

I-1.7 Classical Oscillator Frequencies and Observed Absorption Peaks of Al_2O_3

These data were compiled from Aronson (Ref. 1R-3), Piriou (Ref. 1N-9, 1T-19), Barker (Ref. 1R-4) and Dorsey (Ref. 1T-1). Redundant measurements have not been removed.

λ (μ)	ν (cm^{-1})	Comments	Reference
28.669	348.8		1N-9
25.974	385 ± 1%	ordinary ray	1R-4
25.907	386	strong	1T-1
25.773	388	longitudinal mode, ord. ray	1R-4
25.000	400	extraordinary ray	1R-4
22.936	436	forbidden	1R-4
22.779	439	forbidden	1R-4
22.763	439.3		1N-9
22.624	442 ± 1%	ordinary ray	1R-4
22.472	445	strong	1T-1
22.321	448	forbidden	1R-4
22.222	450	forbidden	1R-4
22.786	459	forbidden	1R-4
21.186	472	forbidden	1R-4
20.833	480 ± 1%	longitudinal mode, ord. ray	1R-4
20.704	483	forbidden	1R-4
20.534	487	strong	1T-1
19.531	512	longitudinal mode, ext. ray	1R-4
17.575	569 ± 1%	ordinary ray	1R-4

λ (μ)	ν (cm^{-1})	Comments	Reference
17.559	569.5		1N-9
17.513	571	forbidden	1R-4
17.153	583		1T-1
17.153	583 ± 1%	extraordinary ray	1R-4
16.892	592	forbidden	1R-4
16.722	598	forbidden	1R-4
16.000	625 ± 1%	longitudinal mode, ord. ray	1R-4
15.773	634		1N-9
15.748	635 ± 1%	ordinary ray	1R-4
15.699	637	forbidden	1R-4
15.674	638	strong	1T-1
15.385	650	forbidden	1R-4
15.290	654 ± 1%	extraordinary ray	1R-4
12.987	770	forbidden	1R-4
12.820 ± 0.05	780 ± 3%		1N-9
12.407	806	forbidden	1R-4
11.481	871	longitudinal mode, ord. ray	1R-4
11.313 ± 0.039	884 ± 3%		1N-9
11.111	900 ± 1%	longitudinal mode, ext. ray	1R-4
10.040	996		1T-19
9.390	1065	strong	1T-19
9.009	1110	strong	1T-19
8.591	1164	strong	1T-19
8.403	1190	medium	1T-19
8.039	1244	strong	1T-19
7.819	1279	strong	1T-19
7.541	1326	strong	1T-19
7.299	1370	medium	1T-19
6.978	1433	strong	1T-19
6.711	1490	strong	1T-19
6.289	1590	medium	1T-19
5.556	~1800	medium	1T-19

I-1.8 Conclusions: Areas Needing Further Research

An examination of the Al_2O_3 literature shows that more research is needed for the following infrared optical properties:

(a) Refractive Index:

Sapphire - no reliable data from 6-9μ have been found.

Bulk Alumina - no measurements of the refractive index have been made.

Powders - the only data obtained are of uncertain value.

(b) Extinction Index:

Powders - the only data obtained are of uncertain value.

(c) Spectral Emittance:

Bulk Alumina - no measurements beyond 15μ have been made

Powdered Alumina - the measurements made for powders indicate only that the emissive properties of particles have not yet been determined.

(d) Total Emissivity:

Powders - except for one Reference (1TE-3) no information has been obtained on $\epsilon(T)$ for powdered materials.

(e) Reflectivity:

Bulk Alumina - a gap exists from 2μ to 8μ.

Powders - no high temperature measurements have been made. The $300^{\circ}K$ measurements of Aronson (Ref. 1R-1) cover 7μ to 30μ.

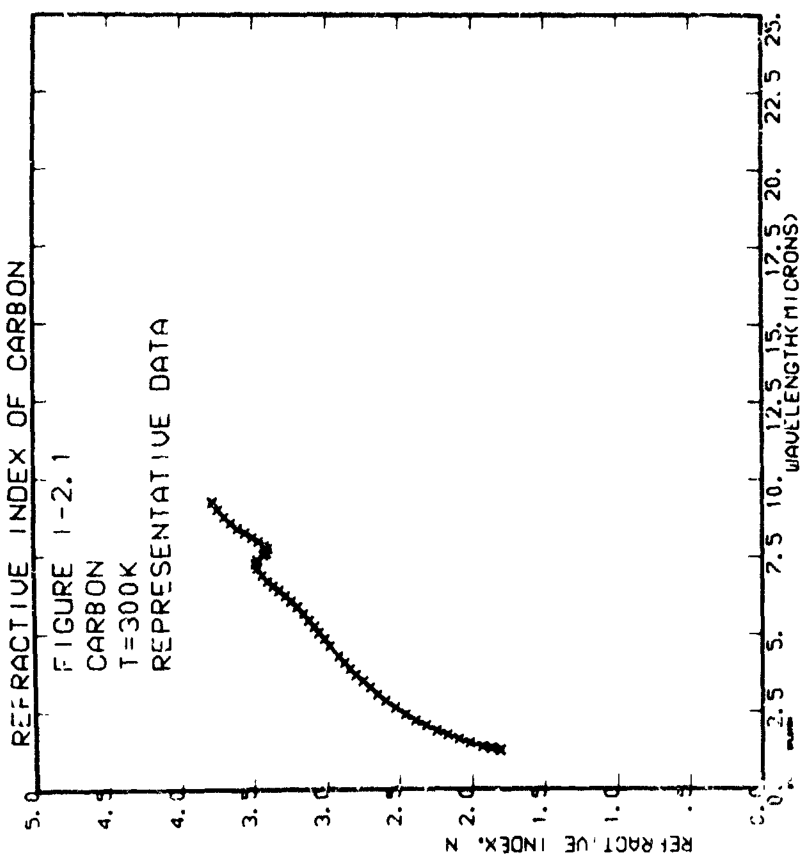
I-2 CARBON PROPERTIES

I-2.1 Refractive Index, n — Carbon

Very few measurements of the refractive index of carbon or graphite exist in the literature. Figure I-2.1 and Table I-2.1 present the data of Foster (Ref. 2N-2) for graphite, which is taken to be representative of carbon and graphite. Refractive index measurements on soot (Ref. 2N-1, 2N-2) indicate that n (λ) increases with wavelength for both graphite and soot, and that the soot data are within a factor of 2 of the graphite data. Glassy carbon measurements (Ref. 2N-10) to 2 μ are in good agreement with the representative curve, as are the pyrolytic graphite data of Lenham (Ref. 2N-6) which extend to 17μ. Fair agreement exists between the representative curve and carbon film data (Ref. 2R-4).

Table I-2.1 Carbon and Graphite Refractive Index - Representative Data

λ	n	λ	n	λ	n	λ	n
.975	1.305E+00	1.028	1.873E+00	1.095	1.932E+00	1.207	2.015E+00
1.329	2.094E+00	1.456	2.170E+00	1.583	2.246E+00	1.749	2.316E+00
1.909	2.388E+00	2.103	2.458E+00	2.324	2.528E+00	2.570	2.599E+00
2.771	2.650E+00	2.989	2.703E+00	3.187	2.749E+00	3.394	2.795E+00
3.584	2.839E+00	3.775	2.879E+00	3.990	2.916E+00	4.298	2.977E+00
4.526	3.014E+00	4.728	3.051E+00	4.931	3.084E+00	5.139	3.118E+00
5.340	3.150E+00	5.552	3.190E+00	5.727	3.238E+00	5.906	3.279E+00
6.080	3.322E+00	6.228	3.361E+00	6.381	3.402E+00	6.594	3.437E+00
6.809	3.471E+00	6.954	3.482E+00	7.089	3.472E+00	7.234	3.429E+00
7.309	3.405E+00	7.450	3.399E+00	7.562	3.418E+00	7.674	3.461E+00
7.804	3.507E+00	7.957	3.559E+00	8.116	3.608E+00	8.293	3.659E+00
8.495	3.701E+00	8.708	3.746E+00	8.350	3.784E+00		


REFRACTIVE INDEX OF CARBON
FIGURE I-2.1
CARBON
T=300K
REPRESENTATIVE DATA
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0.0 .5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0

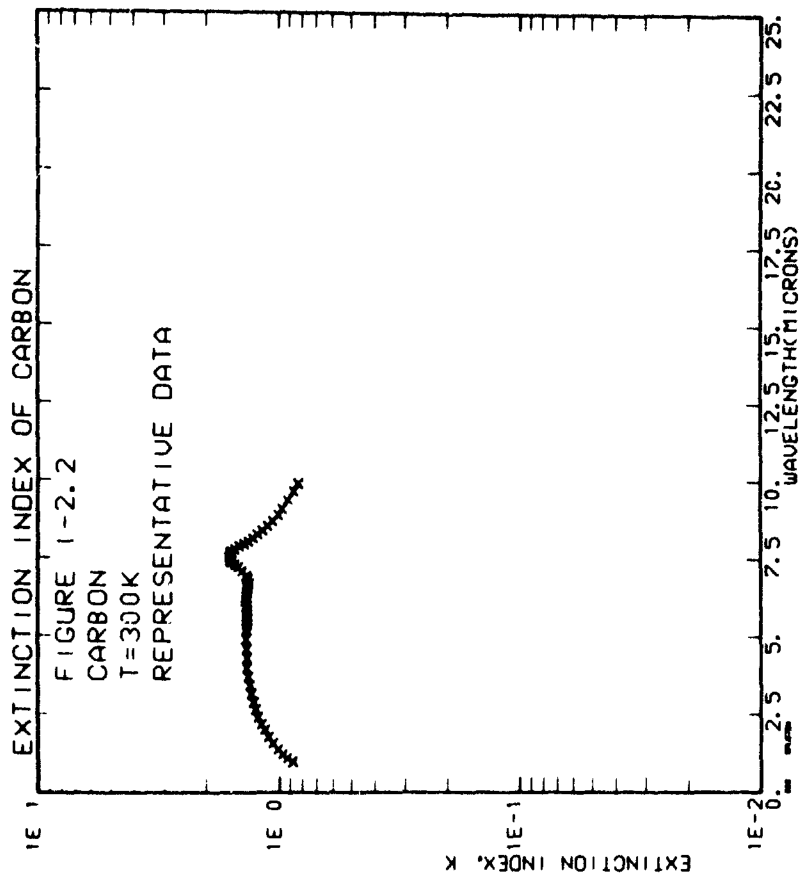
I-2.2 Extinction Index, k - Carbon

The measurements of k for carbon, graphite, and pyrolytic graphite found in the literature are in very poor agreement over all wavelengths. The value of k at 1μ seems to be between 0.5 and 1.0, but the behavior with wavelength is not clearly defined. Krascella (Ref. 2K-7) shows k for carbon smoothly rising to 2.0 at 1.0μ. Foster (Ref. 2K-3) shows for graphite a rise to 1.2 at 4μ, then finally a decrease to 0.8 at 10.0μ. Hennig (Ref. 2K-4) observes for lamellar graphite a rise from 1μ to 2μ of 0.7 to 3.6.

In the absence of coherent information on the extinction index, the data of Foster (Ref. 2K-3) have been chosen as representative. Figure I-2.2 shows these data. All other references are included in Section III-2.2.

Table I-2.2 Carbon Extinction Index - Representative Data

λ	k	λ	k	λ	k	λ	k
.990	8.784E-01	1.120	9.237E-01	1.234	9.652E-01	1.390	1.014E+00
1.573	1.054E+00	1.780	1.108E+00	2.004	1.148E+00	2.183	1.183E+00
2.408	1.215E+00	2.650	1.245E+00	2.884	1.273E+00	3.155	1.298E+00
3.426	1.320E+00	3.720	1.335E+00	3.994	1.351E+00	4.311	1.356E+00
4.588	1.361E+00	4.900	1.362E+00	5.219	1.357E+00	5.364	1.351E+00
5.526	1.351E+00	5.681	1.353E+00	5.825	1.357E+00	5.971	1.360E+00
6.129	1.359E+00	6.250	1.354E+00	6.408	1.350E+00	6.561	1.341E+00
6.690	1.334E+00	6.843	1.343E+00	6.944	1.364E+00	7.088	1.420E+00
7.209	1.466E+00	7.284	1.519E+00	7.358	1.575E+00	7.414	1.598E+00
7.525	1.612E+00	7.657	1.600E+00	7.716	1.574E+00	7.795	1.519E+00
7.875	1.455E+00	7.953	1.391E+00	8.045	1.335E+00	8.144	1.281E+00
8.249	1.225E+00	8.391	1.169E+00	8.534	1.114E+00	8.694	1.061E+00
8.865	1.005E+00	9.079	9.647E-01	9.372	9.119E-01	9.628	8.643E-01
9.892	8.253E-01						


EXTINCTION INDEX OF CARBON
FIGURE I-2.2
CARBON
T=300K
REPRESENTATIVE DATA
EXTINCTION INDEX, K
1E 1
1E 0
1E-1
1E-2
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)

I-2.3 Spectral Emissivity - Carbon

a) The spectral emissivities of high purity graphite and carbon as measured by various authors are sufficiently similar from 1μ to 5μ, the range of most experimental studies, to be considered the same. Wide variations exist in the published data, and the temperature dependence of $\epsilon(\lambda)$, if any, is poorly defined. Nine representative curves have been chosen ranging from $1105^{\circ}K$ to $2850^{\circ}K$. All cover the 1μ to 4μ range, and two, $1105^{\circ}K$ and $1420^{\circ}K$, extend to 13μ. Few conclusions regarding $\epsilon(\lambda)$ in this temperature range can actually be drawn, unfortunately, except that $\epsilon(\lambda) > 0.7$ to about 9μ.

b) Pyrolytic Graphite - pyrolytic graphite is a highly anisotropic material with C face (a-b plane) and A face (c-plane) emittances varying by over a factor of 3 or 4 for much of the spectral regions surveyed.

The data of Kibler (Ref. 2SE-13) indicate for the A face (c-plane) that at 0.5μ, $\epsilon(\lambda)$ is low, but rises to a peak around 1.25μ, then slowly drops (except for $\epsilon(\lambda)$ at $T = 1914^{\circ}K$, which rises slowly and levels off around 2.0μ). There seems to be no simple increase or decrease with temperature. Wilson's (Ref. 2SE-17) data show $\epsilon(\lambda)$ high (~ 1.0) at short wavelengths, with a rapid drop in the infrared. Autio and Scala (Ref. 2SE-3) show generally lower values of $\epsilon(\lambda)$. There is presently no way to choose any one set of data as representative.

The C face is shown by all researchers to have a much lower emissivity that the A face. Kibler (Ref. 2SE-13) has observed a value of $\epsilon(\lambda) < 0.3$ for $\lambda < 1.0\mu$, which slowly increases with wavelength and decreases with increasing temperature.

For both emissivities, readers are referred to Section III-2.3 for measurements made at specific temperatures. For

$T = 1400^{\circ}K$, refer to Autio (Ref. 2SE-3); for $T = 1600^{\circ}$ to $2800^{\circ}K$, refer to Kibler (Ref. 2SE-13); and for T above $2800^{\circ}K$, refer to Wilson (Ref. 2SE-17).

Figure I-2.3 shows, for an example only, $\epsilon(\lambda)$ for the A and C faces from $1800^{\circ}K$ to $1900^{\circ}K$.

Table I-2.3 Carbon Spectral Emissivities - Representative Data

a) T = 1105°K

λ	ε	λ	ε	λ	ε	λ	ε
2.031	.823	2.450	.867	2.727	.802	2.915	.837
3.057	.815	3.365	.835	3.530	.840	3.836	.823
4.069	.800	4.266	.792	4.449	.781	4.619	.778
4.920	.773	5.149	.774	5.406	.753	5.638	.742
5.926	.720	6.093	.722	6.464	.740	6.382	.772
7.105	.784	7.263	.790	7.492	.784	7.799	.762
8.190	.734	8.553	.714	9.091	.761	9.305	.693
10.525	.833	10.948	.673	11.251	.667	11.763	.645
12.049	.834	12.207	.633				

b) T = 1273°K

λ	ε	λ	ε	λ	ε	λ	ε
.526	.857	.770	.875	.941	.887	1.112	.894
1.317	.836	1.583	.901	1.980	.902	2.359	.902
2.734	.834	3.025	.905	3.395	.905	3.763	.907
4.116	.865	4.441	.911	4.706	.914	5.054	.917
5.279	.920						

c) T = 1420°K

λ	ε	λ	ε	λ	ε	λ	ε
2.020	.991	2.196	.967	3.396	.987	3.787	.991
4.259	.970	4.810	.935	5.356	.894	5.905	.857
6.002	.852	6.304	.852	6.611	.864	6.923	.885
7.521	.934	7.685	.940	7.860	.934	8.224	.913
8.534	.831	8.967	.855	9.254	.880	9.818	.880
10.000	.877	10.501	.855	11.561	.834	11.879	.825
12.030	.824	12.314	.833	12.020	.850	12.925	.875
13.232	.891	13.434	.89	13.915	.898		

Table I-2.3 (Continued)

d) T = 1473°K

λ	ε	λ	ε	λ	ε	λ	ε
.544	.85[illegible]	.745	.875	.820	.888	.998	.916
1.160	.921	1.338	.929	1.546	.931	1.871	.931
2.247	.932	2.595	.934	2.988	.936	3.367	.937
3.765	.938	4.129	.940	4.509	.941	4.872	.944
5.125	.945	5.330	.948	5.486	.951		

e) T = 1673°K

λ	ε	λ	ε	λ	ε	λ	ε
.540	.849	.756	.881	.858	.902	1.010	.928
1.098	.939	1.180	.946	1.264	.951	1.403	.953
1.723	.953	2.167	.953	2.586	.953	2.877	.955
3.243	.956	3.569	.959	3.815	.961	4.145	.964
4.420	.967	4.748	.970	5.079	.971	5.378	.971
5.494	.971						

f) T = 1873°K

λ	ε	λ	ε	λ	ε	λ	ε
.564	.870	.717	.892	.783	.914	.875	.932
.974	.945	1.091	.954	1.224	.960	1.349	.962
1.745	.962	2.122	.952	2.318	.964	2.574	.967
2.874	.968	3.224	.969	3.649	.969	3.769	.970
4.154	.971	4.473	.973	4.837	.975	5.163	.976
5.408	.973						

Table I-2.3 (Continued)

g) T = 1882°K, pyrolytic graphite, a-face

λ	ε	λ	ε	λ	ε	λ	ε
.500	.795	.570	.819	.639	.842	.788	.861
.806	.882	.893	.896	.978	.985	1.068	.989
1.149	.912	1.264	.918	1.369	.985	1.479	.899
1.634	.888	1.816	.876	1.968	.863	2.149	.849
2.285	.842	2.431	.833	2.619	.825	2.828	.817
3.024	.807	3.240	.795	3.429	.784	3.638	.771
3.841	.757	3.975	.748	4.876	.741		

h) T = 1808°K, pyrolytic graphite, c-face

λ	ε	λ	ε	λ	ε	λ	ε
1.189	.301	1.359	.323	1.508	.345	1.096	.367
1.830	.336	2.355	.403	2.279	.415	2.506	.427
2.733	.438	2.971	.443	3.193	.451	3.452	.457
3.717	.463	3.983	.465	4.231	.473	4.469	.473
4.715	.475	4.910	.475	5.320	.477		

Table I-2.3 (Continued)

i) T = 2150°K, pyrolytic graphite, c-face

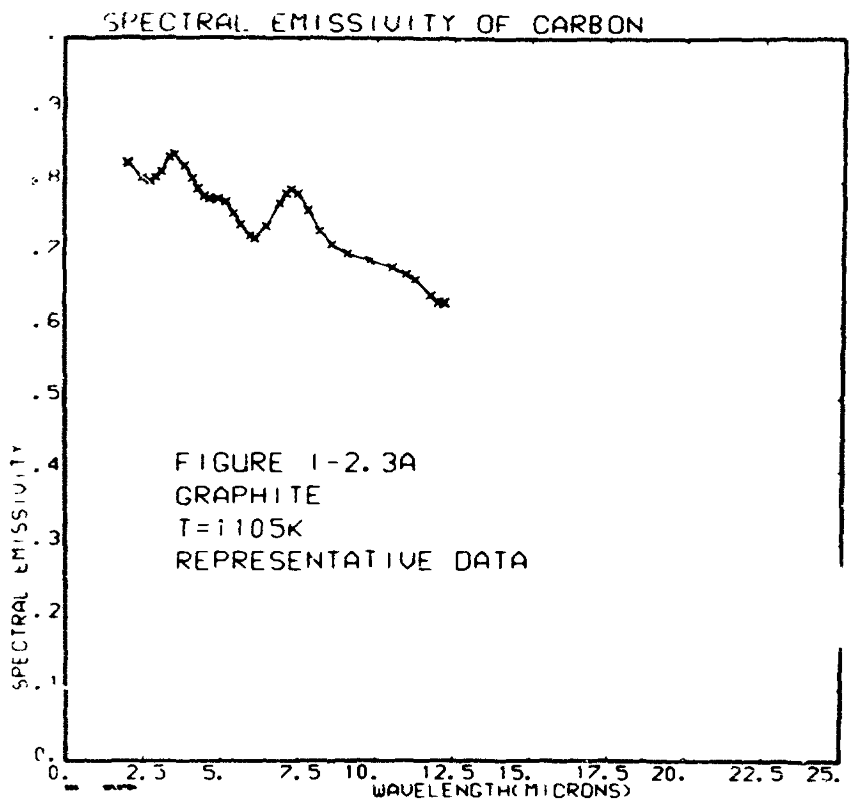
λ	ε	λ	ε	λ	ε	λ	ε
.495	.757	.994	.820	1.473	.860	1.968	.885
2.456	.900	2.939	.908	3.422	.917	3.922	.921
4.417	.922	4.860	.923				

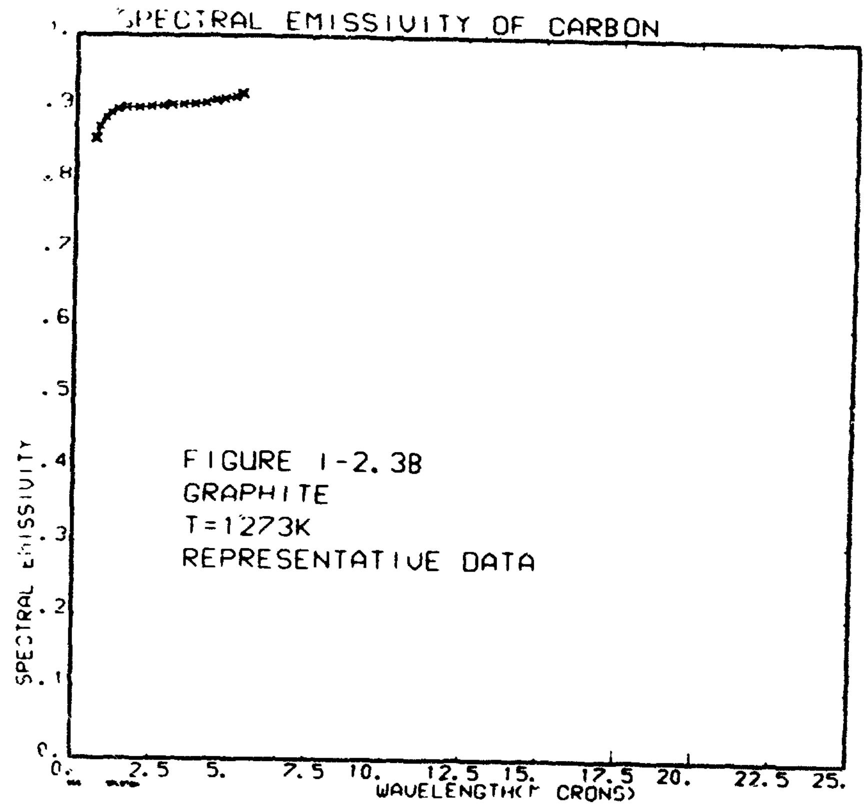
j) T = 2360°K, pyrolytic graphite, c-face

λ	ε	λ	ε	λ	ε	λ	ε
.835	.763	1.778	.809	2.856	.839	3.325	.837
3.532	.830	3.992	.808	4.788	.845	5.266	.871

k) T = 2850°K, pyrolytic graphite, c-face

λ	ε	λ	ε	λ	ε	λ	ε
[illegible]	.929	.644	.905	.798	.910	1.193	.881
1.595	.895	1.998	.873	2.395	.847	2.793	.863


SPECTRAL EMISSIVITY OF CARBON
FIGURE 1-2.3A
GRAPHITE
T=1105K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
.1
.2
.3
.4
.5
.6
.7
.8
.9


SPECTRAL EMISSIVITY OF CARBON
FIGURE 1-2.3B
GRAPHITE
T=1273K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
.1
.2
.3
.4
.5
.6
.7
.8
.9

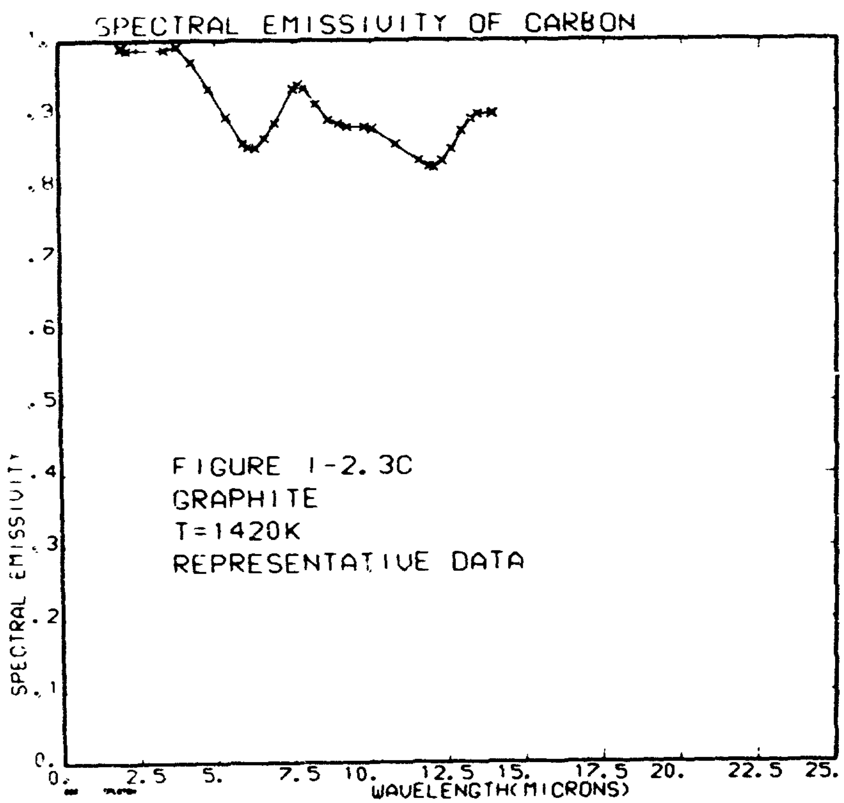


FIGURE I-2.3C
GRAPHITE
T=1420K
REPRESENTATIVE DATA

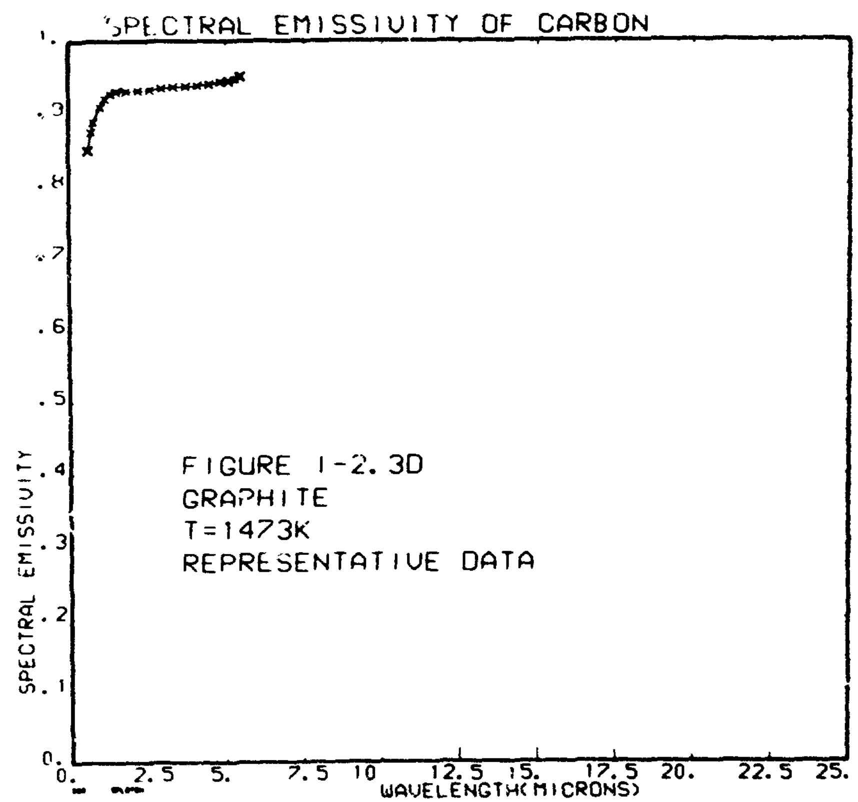


FIGURE I-2.3D
GRAPHITE
T=1473K
REPRESENTATIVE DATA

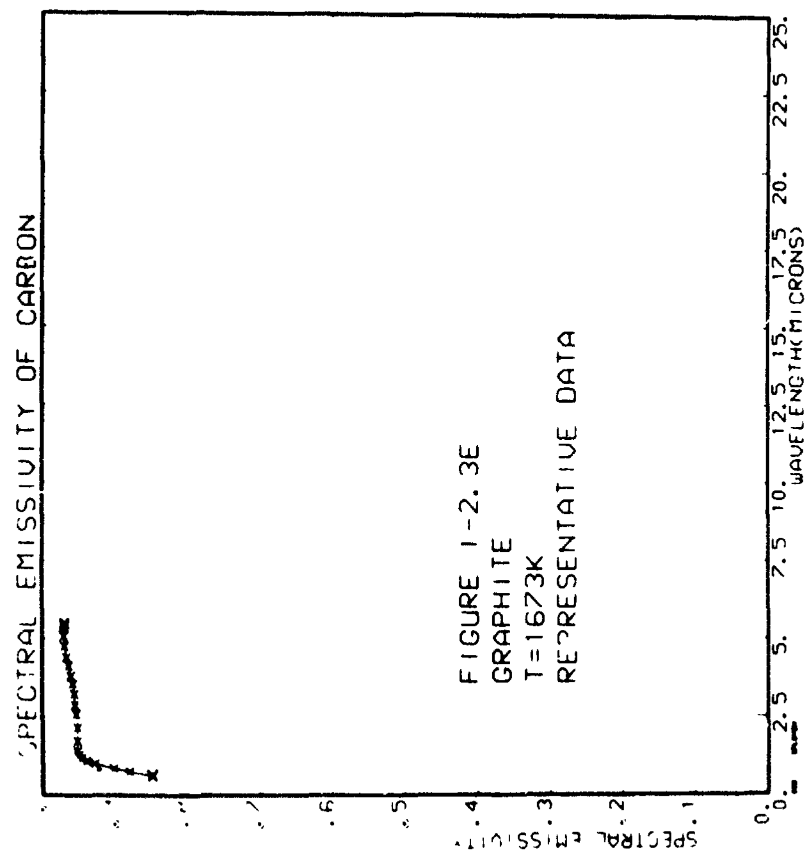


FIGURE I-2.3E
GRAPHITE
T=1673K
REPRESENTATIVE DATA

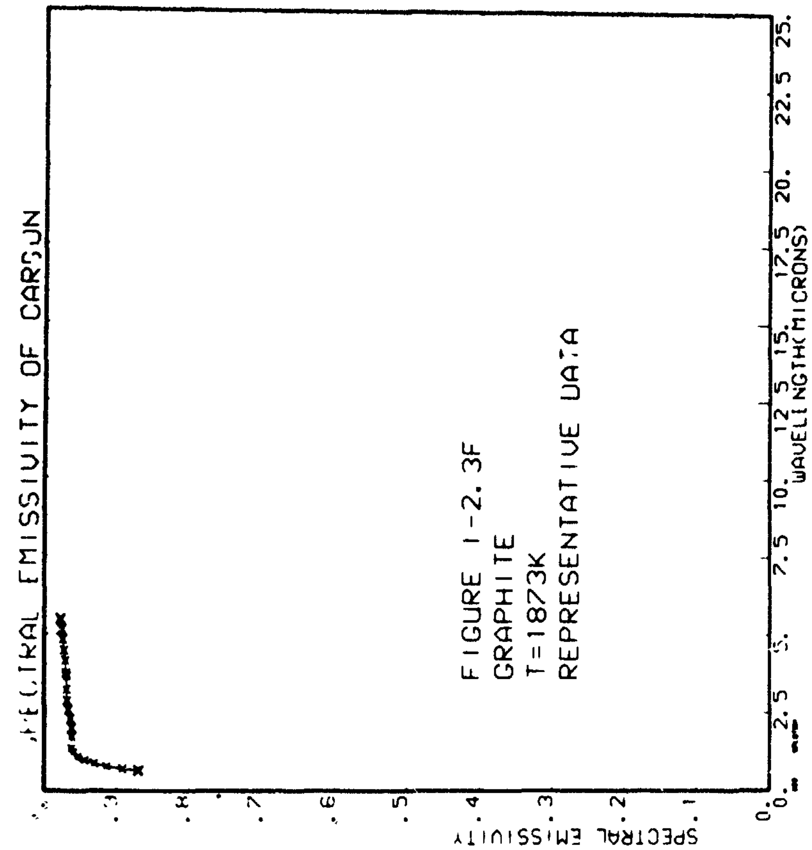


FIGURE I-2.3F
GRAPHITE
T=1873K
REPRESENTATIVE DATA

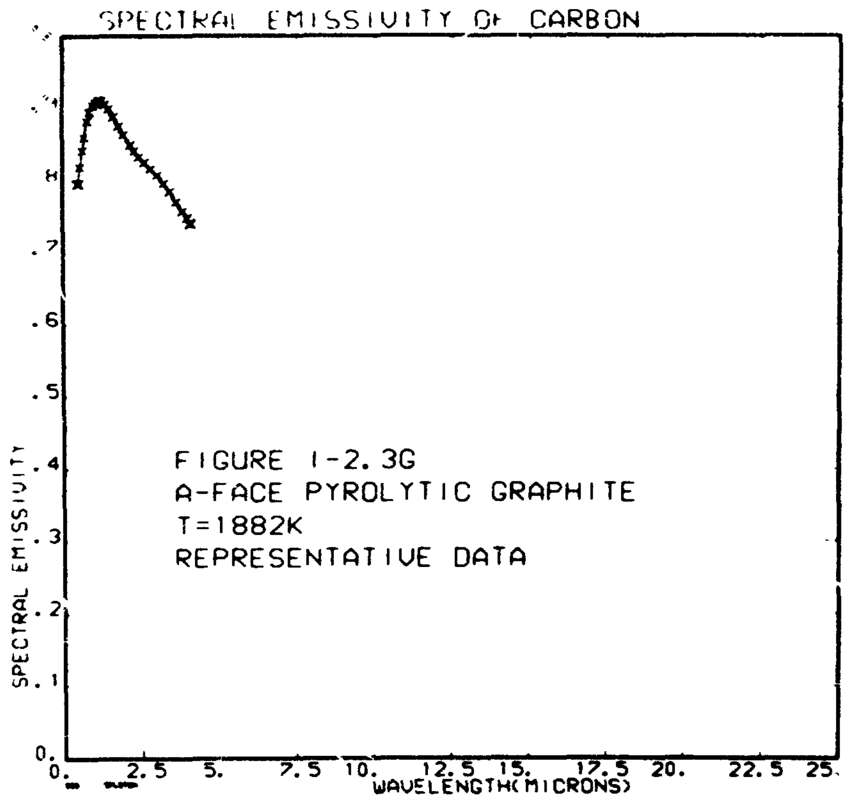


FIGURE I-2.3G
A-FACE PYROLYTIC GRAPHITE
T=1882K
REPRESENTATIVE DATA

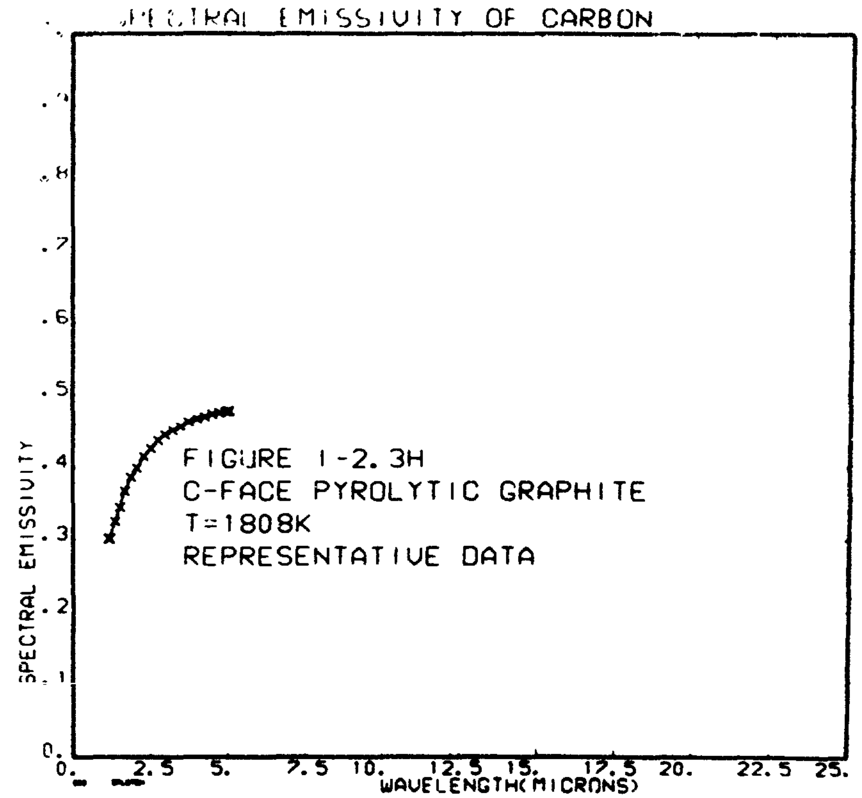


FIGURE I-2.3H
C-FACE PYROLYTIC GRAPHITE
T=1808K
REPRESENTATIVE DATA

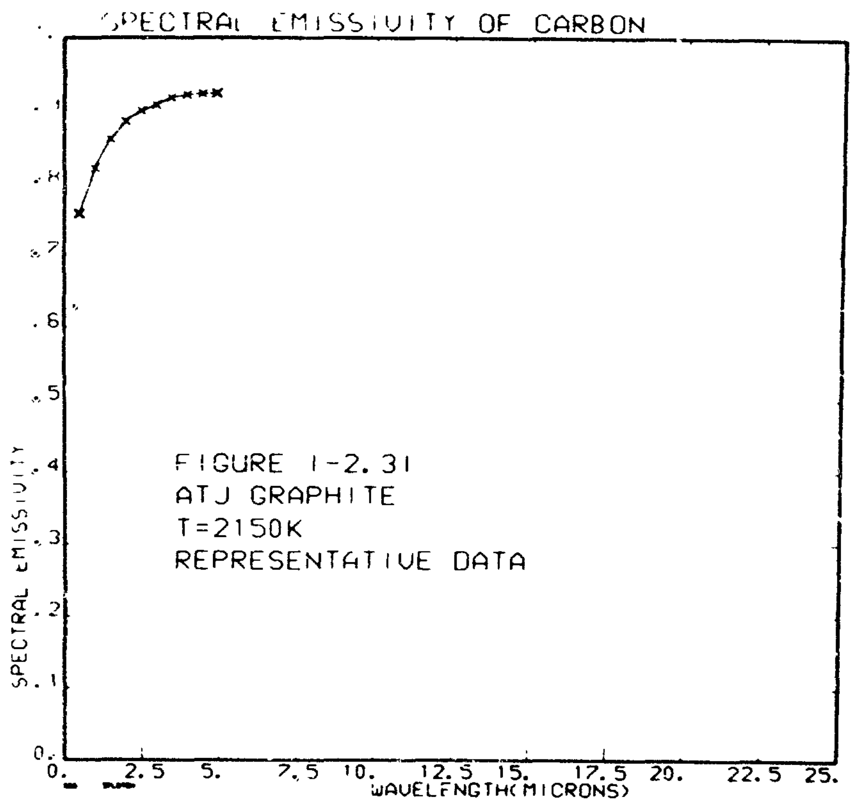


FIGURE I-2.3I
ATJ GRAPHITE
T=2150K
REPRESENTATIVE DATA

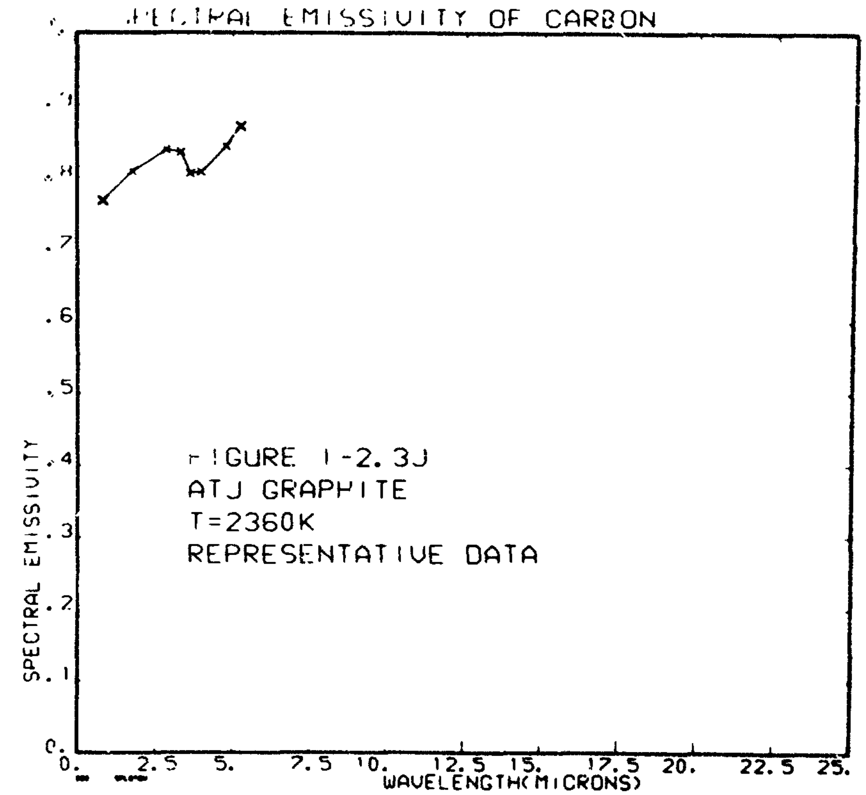
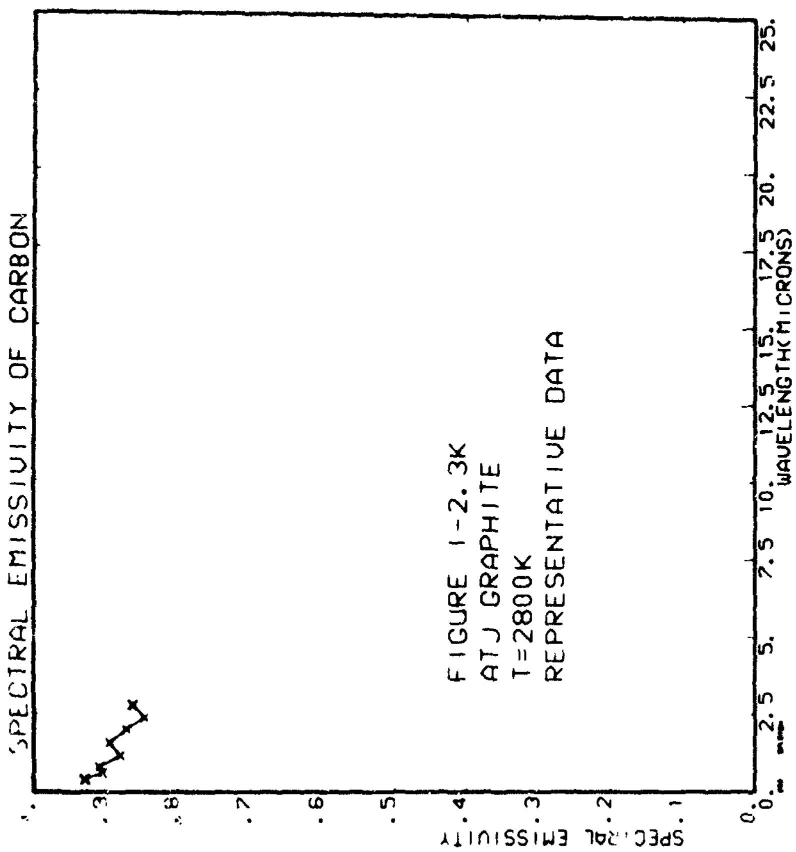


FIGURE I-2.3J
ATJ GRAPHITE
T=2360K
REPRESENTATIVE DATA


SPECTRAL EMISSIVITY OF CARBON
FIGURE I-2.3K
ATJ GRAPHITE
T=2800K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
.1
.2
.3
.4
.5
.6
.7
.8
.9

I-2.4 Total Normal Emissivity, $\epsilon(T)$ - Carbon

A representative value for $\epsilon(T)$ of unpolished carbon or graphite, including the graphites H1LM, H3LM, AGX, AGKSP, ATJ, ATJS, AUC, GA, GBE, GNH, 60 580, 7087, 7100 and 3474D, and L113SP high purity carbon, for temperatures ranging from 500 to 3000°K is approximately 0.85 ± 5 percent.

Section III-2.4 contains the processed data for $\epsilon(T)$ found in the literature for many specific varieties of carbons and graphites.

Touloukian (Ref. 2TE-8) shows pyrolytic graphite as being highly anisotropic in $\epsilon(T)$, just as it was in $\epsilon(\lambda)$; the single temperature measurements of Wilson (Ref. 2TE-10) at temperatures above 2200°K do not confirm this behavior however. Both sets of data are presented in Section III-2.4.

In using these $\epsilon(T)$ data one must take care to apply them only to materials with surfaces prepared in a manner similar to that in which the original samples were prepared. Surface oxidation can cause very large changes in emissivity, and polishing can orient the surface microcrystals, resulting in pyrolytic-like emissivities for graphites.

I-2.5 Reflectance - Carbon

Correlation between reflectivities and emissivities is very poor for all published reflectivity data except Wilson's (Ref. 2R-5) which are included in Section I-2.3. Section III-2.5 presents one single crystal reflectivity and two polycrystalline graphite reflectivities, none of which have any meaningful properties in common.

I-2.8 Conclusions: Areas Needing Further Research

No particulate optical properties have been measured for pure particles, and the variations found in the data for soot make extrapolation of the information to carbon very uncertain.

The refractive index and extinction index for bulk carbon, graphite, and pyrolytic graphite are not known with enough certainty to state if they are higher or lower at 8μ compared to 1μ, and so need to be measured carefully.

The spectral emissivities of bulk graphite, pyrolytic graphite, and carbon are known to approximately $\pm$ 5 percent for some materials, but the variations with temperature are not clearly determined. Also, no $300^{\circ}K$ emissivity measurements have been made. The total normal emissivity is known to be 0.85 $\pm$ 5 percent for a wide range of materials, and measurements are only necessary for specific materials where great precision is desired.

In summary, most optical properties of carbon are poorly known, and all, with the possible exception of $\varepsilon(T)$, need further research.

I-3 MAGNESIUM OXIDE PROPERTIES

I-3.1 Refractive Index, n — Magnesium Oxide

Figure I-3.1 shows the representative curve for the MgO refractive index at 300°K. No fine structure is visible except for the maximum in the region of 25.5μ. Data for single crystal MgO, MgO evaporated films, and polycrystalline MgO are in good agreement from 1μ to 9μ; for wavelengths longer than 9μ, only single crystal measurements have been made. Measurements of n at high temperatures can be found in Section III-3.1.

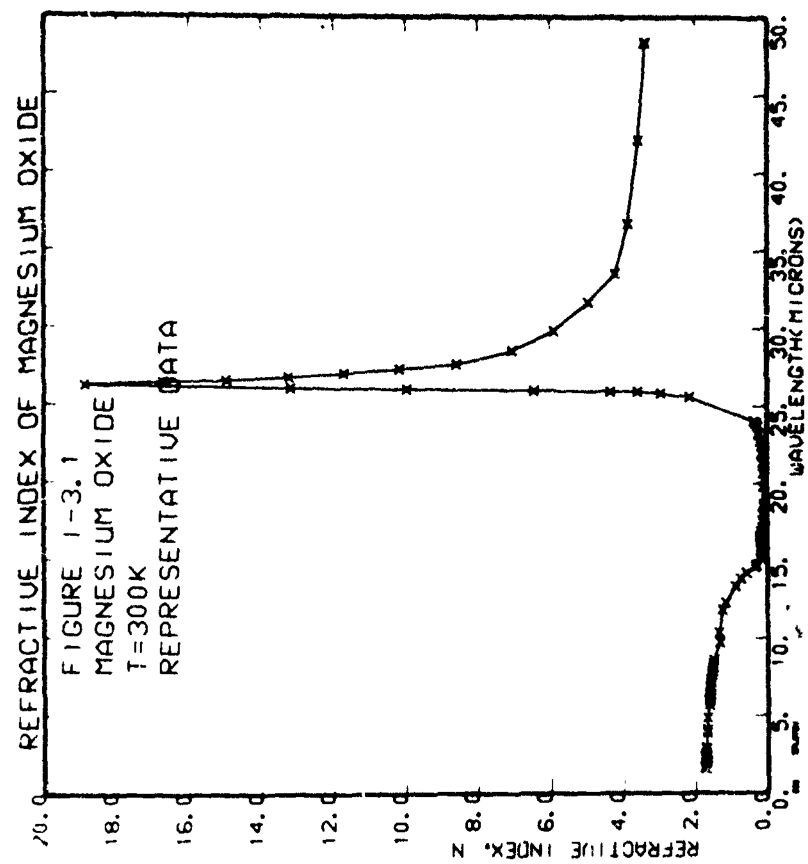
The representative curve was constructed using the data of Kodak (Ref. 3N-6), Piriou (Ref. 3N-8) and Stephens (Ref. 3N-11).

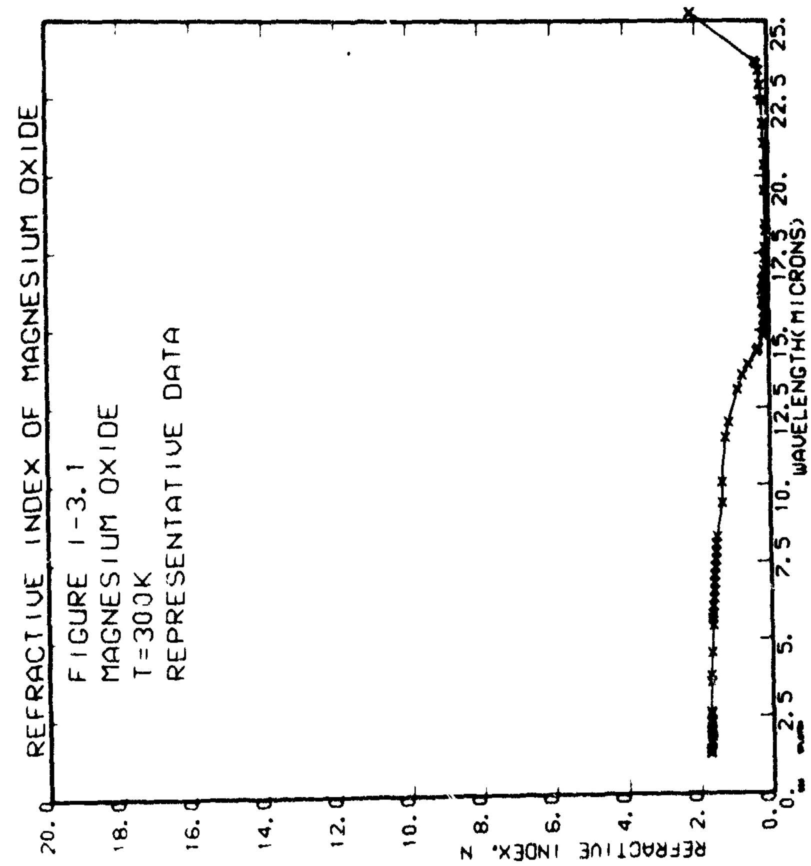
Table I-3.1 Representative Refractive Index — Magnesium Oxide

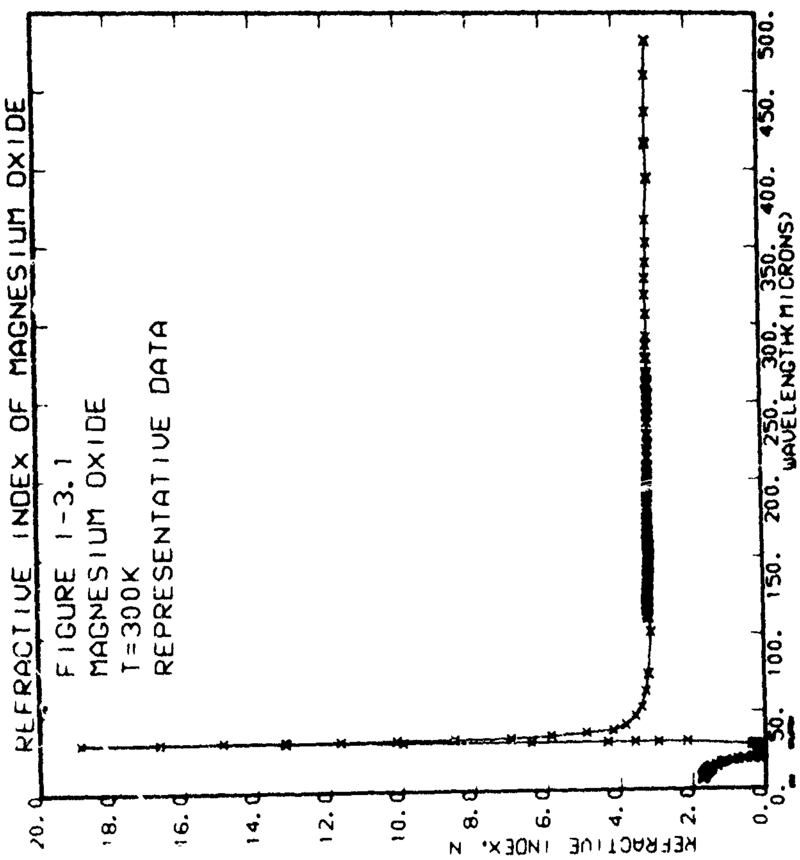
λ	n	λ	n	λ	n	λ	n
1.014	1.723E+00	1.129	1.721E+00	1.367	1.717E+00	1.530	1.715E+00
1.693	1.713E+00	1.709	1.713E+00	1.813	1.711E+00	1.970	1.709E+00
2.249	1.705E+00	2.325	1.703E+00	3.303	1.685E+00	3.508	1.681E+00
4.258	1.660E+00	5.138	1.631E+00	5.350	1.624E+00	5.500	1.618E+00
5.750	1.607E+00	6.000	1.596E+00	6.250	1.584E+00	6.500	1.572E+00
6.750	1.559E+00	7.000	1.545E+00	7.250	1.531E+00	7.500	1.515E+00
7.750	1.499E+00	8.000	1.482E+00	9.109	1.337E+00	9.784	1.344E+00
11.228	1.238E+00	11.727	1.155E+00	12.787	8.925E-01	13.263	7.454E-01
13.609	5.790E-01	14.032	3.445E-01	14.105	3.007E-01	14.580	1.653E-01
14.820	1.499E-01	15.049	1.481E-01	15.299	1.532E-01	15.645	1.717E-01
15.998	1.952E-01	16.322	1.618E-01	16.626	1.368E-01	17.030	1.159E-01
17.395	1.048E-01	17.934	9.750E-02	18.133	9.580E-02	19.238	1.827E-01
20.071	1.157E-01	20.768	1.306E-01	21.379	1.510E-01	22.123	1.958E-01
22.635	2.318E-01	23.121	2.739E-01	23.328	3.161E-01	23.404	3.588E-01
24.972	2.150E+00	25.229	2.949E+00	25.319	3.580E+00	25.323	4.351E+00
25.393	6.455E+00	25.434	9.980E+00	25.467	1.321E+01	25.655	1.889E+01
25.862	1.670E+01	25.991	1.496E+01	26.173	1.325E+01	26.412	1.171E+01
26.745	1.016E+01	27.003	8.562E+00	27.917	7.027E+00	29.213	5.896E+00
31.048	4.926E+00	32.926	4.191E+00	36.122	3.841E+00	41.517	3.571E+00
47.752	3.304E+00	57.463	3.270E+00	68.926	3.178E+00	66.926	3.178E+00
95.822	3.102E+00	104.790	3.166E+00	105.200	3.183E+00	106.210	3.194E+00
108.270	3.200E+00	109.670	3.185E+00	111.850	3.204E+00	112.280	3.197E+00
112.220	3.189E+00	112.420	3.193E+00	114.840	3.202E+00	116.080	3.205E+00
118.930	3.192E+00	119.390	3.197E+00	120.000	3.184E+00	120.140	3.189E+00
120.940	3.180E+00	121.370	3.185E+00	122.000	3.190E+00	123.010	3.179E+00
128.000	3.169E+00	130.600	3.164E+00	130.730	3.159E+00	131.470	3.156E+00
132.640	3.174E+00	132.720	3.164E+00	134.120	3.170E+00	135.280	3.158E+00
137.170	3.145E+00	139.540	3.157E+00	141.360	3.150E+00	143.680	3.163E+00
145.640	3.132E+00	145.700	3.144E+00	148.020	3.140E+00	148.250	3.150E+00
150.690	3.136E+00	151.800	3.164E+00	153.450	3.151E+00	153.940	3.162E+00
154.550	3.159E+00	156.880	3.155E+00	157.560	3.166E+00	159.750	3.163E+00
162.290	3.155E+00	165.260	3.150E+00	167.200	3.153E+00	168.830	3.161E+00
171.770	3.156E+00	174.550	3.146E+00	179.460	3.164E+00	182.740	3.148E+00

Table I-3.1 (Continued)

λ	n	λ	n	λ	n	λ	n
182.750	3.156E+00	183.180	3.159E+00	186.530	3.155E+00	187.310	3.169E+00
191.040	3.157E+00	191.080	3.163E+00	194.100	3.140E+00	197.960	3.144E+00
201.320	3.144E+00	202.680	3.138E+00	207.850	3.142E+00	213.370	3.140E+00
216.270	3.126E+00	222.630	3.139E+00	222.770	3.131E+00	230.460	3.148E+00
234.520	3.136E+00	235.360	3.142E+00	235.500	3.132E+00	239.410	3.114E+00
239.550	3.119E+00	240.320	3.124E+00	247.730	3.128E+00	248.810	3.132E+00
250.150	3.137E+00	255.000	3.129E+00	255.270	3.124E+00	256.500	3.143E+00
261.540	3.122E+00	263.070	3.129E+00	272.030	3.132E+00	272.360	3.145E+00
280.740	3.142E+00	286.250	3.129E+00	300.860	3.135E+00	313.050	3.153E+00
323.840	3.147E+00	333.800	3.122E+00	346.490	3.118E+00	361.240	3.123E+00
387.900	3.070E+00	388.210	3.074E+00	409.660	3.098E+00	410.970	3.102E+00
430.800	3.107E+00	454.400	3.110E+00	476.420	3.091E+00	501.310	3.083E+00
511.680	3.138E+00	535.640	3.089E+00	541.050	3.115E+00	578.570	3.130E+00
622.560	3.140E+00	624.680	3.146E+00	672.380	3.158E+00	719.860	3.108E+00
797.130	3.158E+00	878.500	3.149E+00				


REFRACTIVE INDEX OF MAGNESIUM OXIDE
FIGURE I-3.1
MAGNESIUM OXIDE
T=300K
REPRESENTATIVE DATA
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)


REFRACTIVE INDEX OF MAGNESIUM OXIDE
FIGURE I-3.1
MAGNESIUM OXIDE
T=300K
REPRESENTATIVE DATA
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)


REFRACTIVE INDEX OF MAGNESIUM OXIDE
FIGURE I-3.1
MAGNESIUM OXIDE
T=300K
REPRESENTATIVE DATA
REFRACTIVE INDEX, Z
WAVELENGTH (MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0

I-3.2 Extinction Index, k — Magnesium Oxide

Figure I-3.2 shows the representative curves for the MgO extinction coefficient at T = 300°K. High temperature measurements are graphed and tabulated in Section III-3.2. The extinction coefficient shows little structure except in the 10.2μ, 11.6μ and 25μ regions. Measurements made by Hanna (Ref. 3K-3, 3K-4) indicate that, except at short wavelengths (< 9μ), single crystal MgO and polycrystalline MgO have similar transmissive properties.

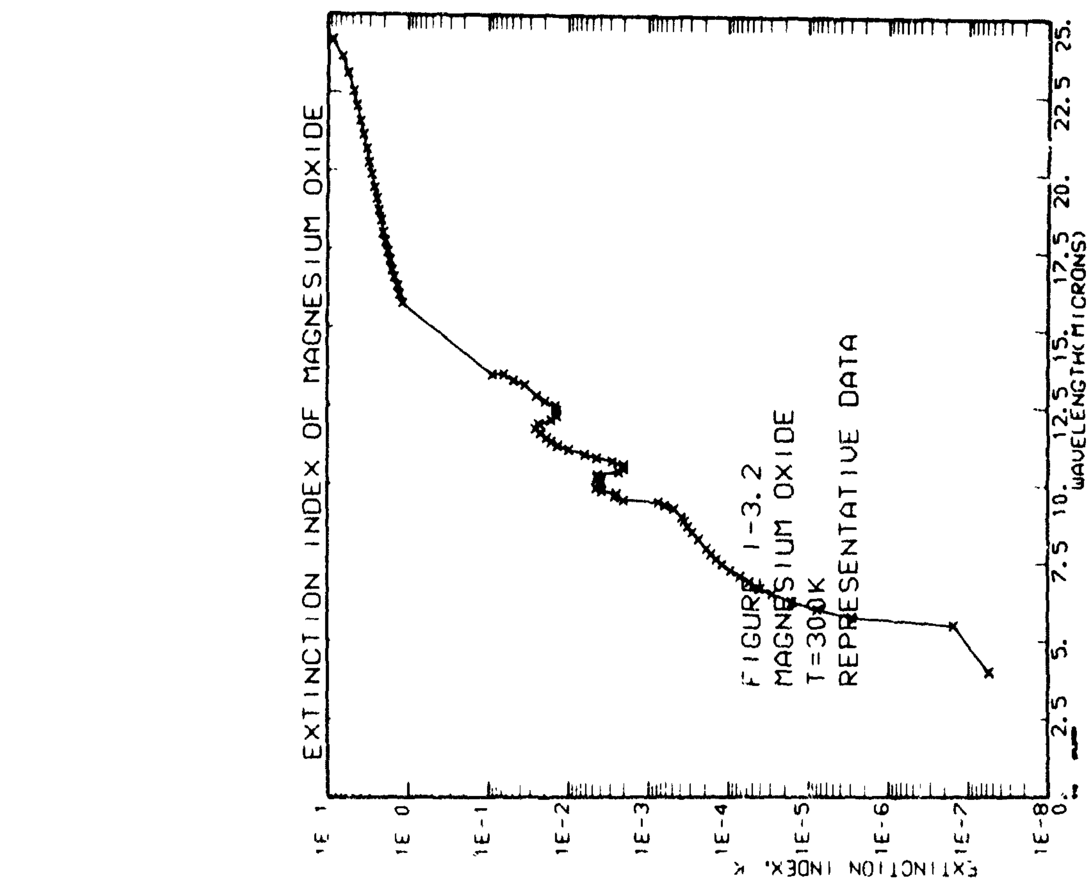
The representative curve was constructed using the data of Oppenheim (Ref. 3K-10), Andermann (Ref. 3K-1), Hanna (Ref. 3K-4), and Rowntree (Ref. 3K-15). A linear interpolation was made from 55μ to 90μ, an area of the spectrum where the data of Plendl (Ref. 3K-13) indicate a lack of structure.

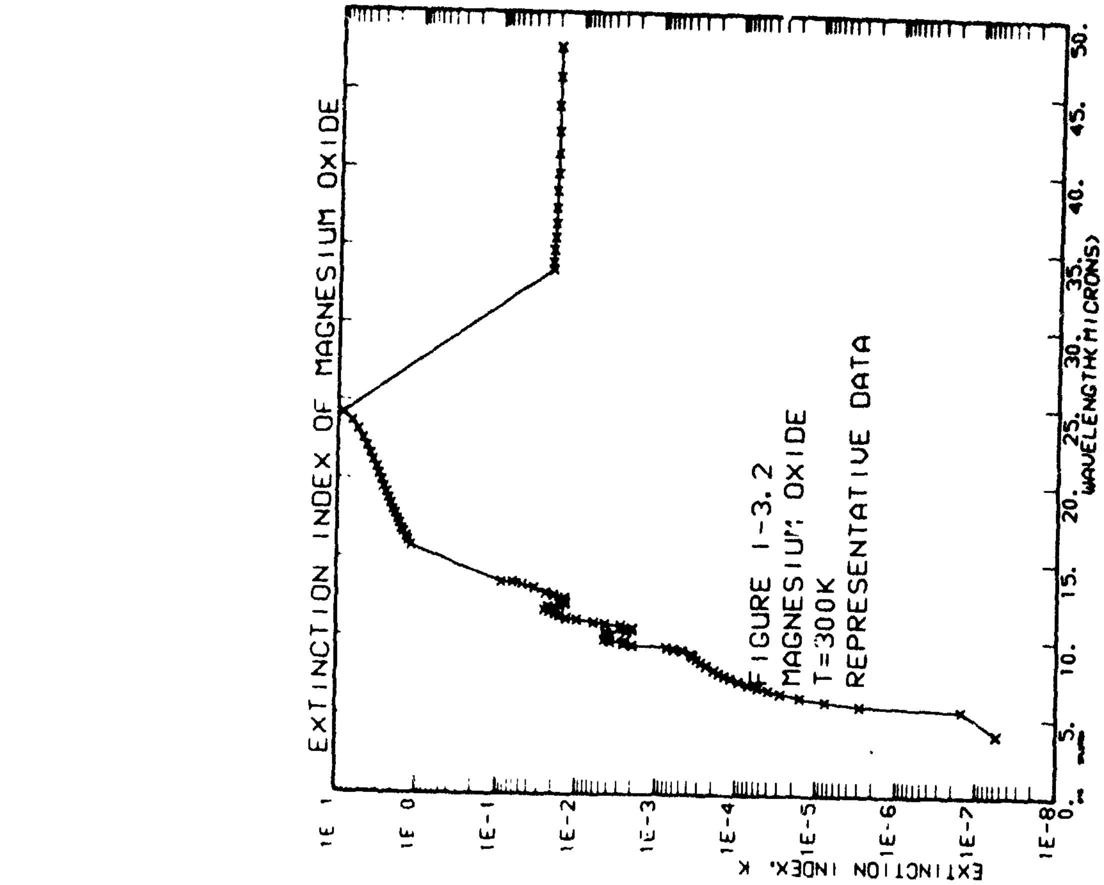
Table I-3.2 Magnesium Oxide Extinction Coefficient, T = 300°K — Representative Data

λ	k	λ	k	λ	k
4.0[illegible]1	5.613E-08	5.498	1.515E-07	5.750	2.813E-06
[illegible]	7.610E-06	6.257	1.621E-05	6.500	2.799E-05
6.535	4.023E-05	6.890	5.506E-05	7.052	7.106E-05
7.251	9.419E-05	7.462	1.191E-04	7.620	1.391E-04
7.788	1.633E-04	7.967	1.903E-04	8.251	2.371E-04
8.421	2.814E-04	8.672	3.159E-04	8.846	3.507E-04
8.971	3.766E-04	9.244	4.722E-04	9.331	6.239E-04
9.423	7.420E-04	9.520	2.024E-03	9.611	2.614E-03
9.7[illegible]	2.436E-03	9.793	3.794E-03	9.891	4.486E-03
9.995	3.997E-03	10.099	3.912E-03	10.198	4.334E-03
10.300	4.331E-03	10.401	2.310E-03	10.505	2.024E-03
10.625	2.024E-03	10.746	2.799E-03	10.849	4.418E-03
10.9[illegible]	6.121E-03	11.104	3.933E-03	11.224	1.346E-02
11.352	1.651E-02	11.494	1.899E-02	11.638	2.243E-02
11.777	2.606E-02	11.941	2.346E-02	12.048	1.644E-02
12.192	1.430E-02	12.359	1.410E-02	12.503	1.459E-02
12.572	1.976E-02	12.833	2.456E-02	13.183	3.479E-02
13.34[illegible]	4.842E-02	13.514	6.403E-02	13.514	8.922E-02
15.778	1.184E+00	16.070	1.284E+00	16.327	1.348E+00
16.617	1.437E+00	16.839	1.585E+00	17.157	1.695E+00
17.438	1.793E+00	17.756	1.917E+00	18.027	2.063E+00
18.444	2.174E+00	18.769	2.307E+00	19.129	2.479E+00
19.493	2.686E+00	19.905	2.825E+00	20.266	3.084E+00
20.701	3.325E+00	21.157	3.619E+00	21.576	3.998E+00
22.053	4.391E+00	22.564	4.896E+00	23.145	5.676E+00
23.649	6.633E+00	24.192	9.922E+00	33.497	2.249E-02
33.988	2.221E-02	34.790	2.184E-02	35.569	2.153E-02
36.493	2.119E-02	37.480	2.089E-02	38.563	2.062E-02
39.679	2.031E-02	40.983	1.999E-02	42.380	1.981E-02
44.017	1.956E-02	45.887	1.938E-02	47.755	1.935E-02
50.125	1.932E-02	52.802	1.942E-02	55.877	1.966E-02
91.514	1.336E-02	95.991	1.356E-02	100.655	1.164E-02
110.723	1.026E-02	115.889	8.374E-03	120.871	5.433E-03
121.457	6.009E-03	125.648	5.180E-03	130.649	3.991E-03
130.649	3.645E-03	131.511	4.319E-03	139.014	3.516E-03
139.047	3.402E-03	151.100	2.807E-03	151.492	3.381E-03
151.[illegible]29	3.292E-03	160.271	2.613E-03	174.175	2.708E-03
161.592	2.519E-03	189.823	2.268E-03	190.133	2.206E-03
190.177	2.148E-03	200.370	2.086E-03	211.828	2.262E-03

Table I-3.2 Continued

λ	k	λ	k	λ	k
211.877	1.939E-03	228.900	2.028E-03	228.959	1.765E-03
250.4[illegible]	1.830E-03	250.744	1.833E-03	250.916	1.791E-03
251.145	1.749E-03	268.486	1.595E-03	268.609	1.725E-03
269.039	1.672E-03	269.101	1.547E-03	290.860	1.648E-03
291.457	1.602E-03	291.670	1.459E-03	307.286	1.393E-03
307.5[illegible]	1.33[illegible]E-03	307.642	1.300E-03	307.928	1.357E-03
330.8[illegible]	1.114E-03	331.254	1.180E-03	331.945	1.365E-03
332.099	1.325E-03	349.370	1.087E-03	350.357	1.116E-03
350.438	1.220E-03	372.539	9.272E-04	373.058	1.179E-03
400.277	6.[illegible]38E-04	400.923	1.043E-03	428.543	8.663E-04
449.673	9.0[illegible]8E-04	469.328	8.709E-04	497.012	7.595E-04
497.815	7.836E-04	526.549	6.293E-04	527.405	7.417E-04
554.379	5.415E-04	581.518	5.872E-04	620.979	6.124E-04
645.511	6.054E-04				


EXTINCTION INDEX OF MAGNESIUM OXIDE
FIGURE I-3.2
MAGNESIUM OXIDE
T=300K
REPRESENTATIVE DATA
EXTINCTION INDEX, K
1E 1
1E 0
1E-1
1E-2
1E-3
1E-4
1E-5
1E-6
1E-7
1E-8
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
WAVELENGTH(MICRONS)


EXTINCTION INDEX OF MAGNESIUM OXIDE
FIGURE I-3.2
MAGNESIUM OXIDE
T=300K
REPRESENTATIVE DATA
EXTINCTION INDEX, K
1E 1
1E 0
1E-1
1E-2
1E-3
1E-4
1E-5
1E-6
1E-7
1E-8
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
WAVELENGTH(MICRONS)

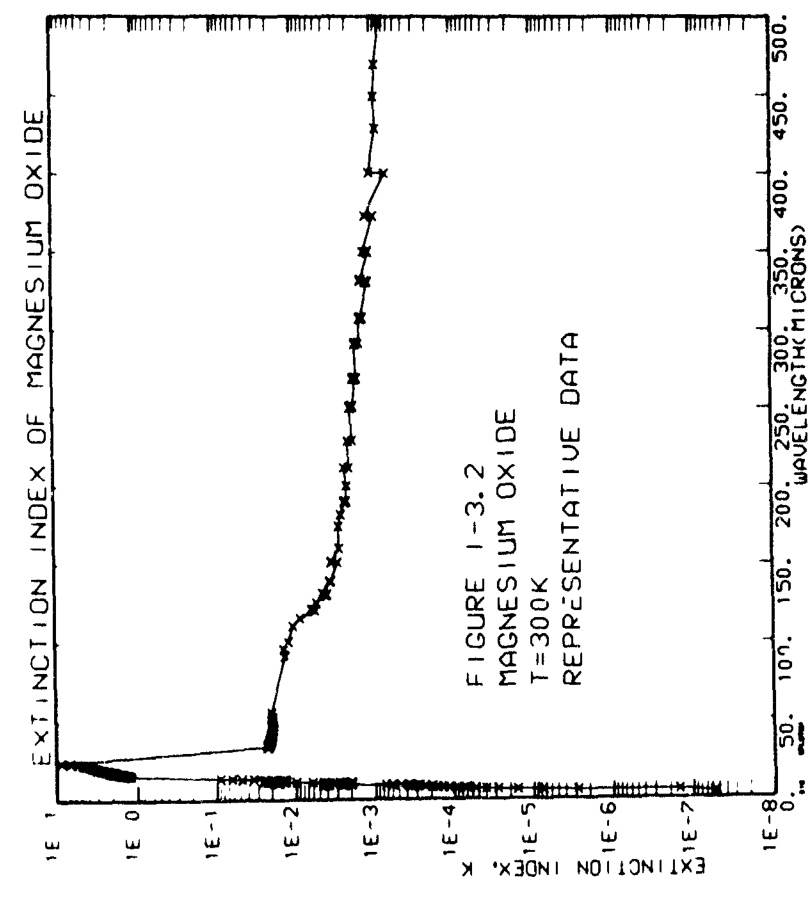


FIGURE I-3.2
MAGNESIUM OXIDE
T=300K
REPRESENTATIVE DATA

I-3.3 Spectral Emissivity, ϵ (λ) – MgO

Only three sources for magnesium oxide spectral emissivity were found, all for the polycrystalline form. The data of Clark (Ref. 3SE-4) and Stierwalt (Ref. 3SE-10) at T = 1600°K and 200°K are presented here in Figures I-3.3 a and b.

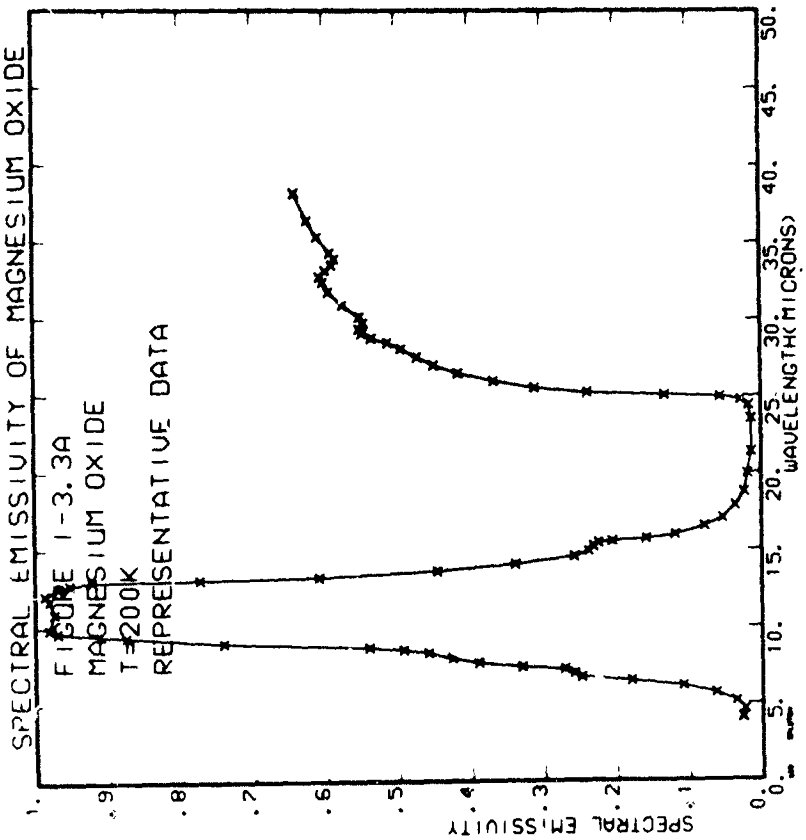
Table I-3.3 Representative Spectral Emissivity, MgO

a) T = 200°K

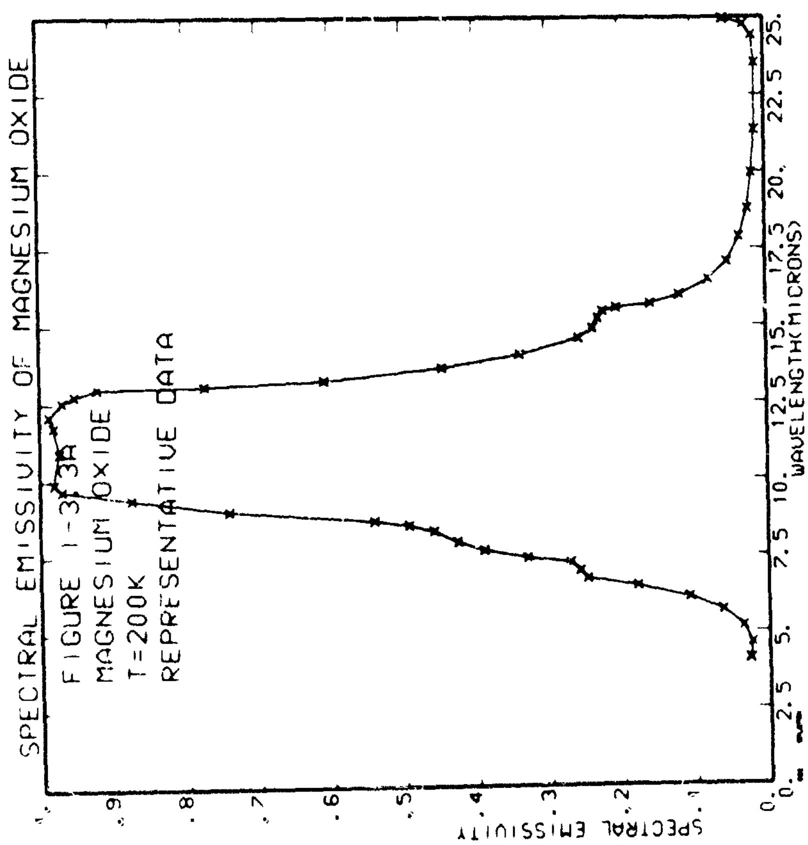
λ	ε	λ	ε	λ	ε	λ	ε
4.1[illegible]	.027	4.647	.023	5.175	.035	5.711	.063
5.142	.13[illegible]	6.515	.179	6.755	.249	7.002	.258
7.275	.271	[illegible].425	.331	7.669	.398	7.953	.426
8.293	.459	8.322	.493	8.672	.542	8.985	.742
9.379	.875	9.687	.971	9.898	.981	10.901	.975
11.769	.981	12.115	.987	12.553	.969	12.772	.953
12.962	.922	13.358	.774	13.239	.609	13.631	.447
14.[illegible]	.338	14.591	.257	14.907	.237	15.234	.250
15.469	.223	15.580	.204	15.703	.157	15.975	.118
16.[illegible]97	.[illegible]78	17.360	.053	17.866	.036	18.775	.023
19.559	.018	21.365	.014	23.535	.013	24.440	.016
24.776	.023	24.971	.056	25.084	.131	25.238	.237
25.536	.311	25.967	.357	26.464	.415	27.004	.449
27.515	.473	28.671	.493	28.460	.512	28.782	.536
29.054	.546	29.364	.552	29.749	.547	30.179	.551
30.899	.574	31.768	.594	32.400	.603	32.779	.606
33.174	.598	33.540	.590	33.898	.585	34.309	.592
35.357	.61[illegible]	36.432	.624	38.199	.640		

b) T = 1600°K

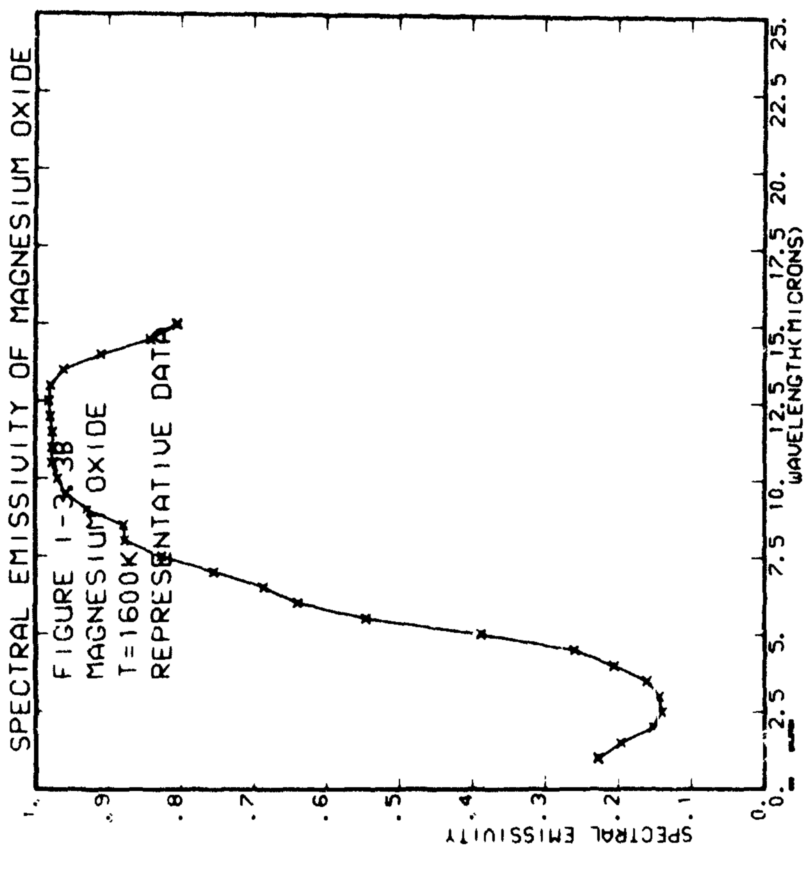
λ	ε	λ	ε	λ	ε	λ	ε
1.000	.227	1.500	.135	2.000	.151	2.500	.141
3.000	.144	3.500	.150	4.000	.[illegible]05	4.500	.260
5.000	.338	[illegible].500	.545	6.000	.640	6.500	.687
7.000	.75[illegible]	[illegible].500	.827	8.000	.878	8.500	.879
9.000	.929	[illegible].500	.959	10.000	.970	10.500	.978
11.000	.977	11.500	.977	12.000	.980	12.500	.982
13.000	.979	13.500	.962	14.000	.910	14.500	.842
15.000	.[illegible]						



SPECTRAL EMISSIVITY OF MAGNESIUM OXIDE
FIGURE I-3.3A
MAGNESIUM OXIDE
T=200K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)



SPECTRAL EMISSIVITY OF MAGNESIUM OXIDE
FIGURE I-3.3A
MAGNESIUM OXIDE
T=200K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)



SPECTRAL EMISSIVITY OF MAGNESIUM OXIDE
FIGURE I-3.3B
MAGNESIUM OXIDE
T=1600K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

I-3.4 Total Normal Emissivity, ϵ (λ) — Magnesium Oxide

The total emissivity of polycrystalline MgO has been measured for temperatures ranging from 29°K to 1800°K. The representative curve for magnesia data, constructed by fitting a third order polynomial to data from References 3TE-6 and 3TE-8 is shown in Figure I-3.4, and tabulated in Table I-3.4.

ϵ (T) is seen to decrease with temperature from a high of $\sim$0.7 to under 0.3 at 1500°K. This behavior is very similar to that of ϵ (λ) of alumina.

No experimental error is quoted for these data.

Table I-3.4 Polynomial Fit to the Experimental Data

T	ε (T)	T	ε(T)	T	ε(T)
20.000	0.7201	920.000	0.4262	1820.000	0.3021
40.000	0.7170	940.000	0.4189	1840.000	0.3069
60.000	0.7136	960.000	0.4117	1860.000	0.3121
80.000	0.7099	980.000	0.4046	1880.000	0.3178
100.000	0.7060	1000.000	0.3976	1900.000	0.3239
120.000	0.7018	1020.000	0.3907	1920.000	0.3306
140.000	0.6974	1040.000	0.3839	1940.000	0.3377
160.000	0.6928	1060.000	0.3773	1960.000	0.3453
180.000	0.6879	1080.000	0.3708	1980.000	0.3534
200.000	0.6829	1100.000	0.3644	2000.000	0.3620
220.000	0.6776	1120.000	0.3582	2020.000	0.3711
240.000	0.6721	1140.000	0.3522	2040.000	0.3808
260.000	0.6664	1160.000	0.3463	2060.000	0.3910
280.000	0.6606	1180.000	0.3407	2080.000	0.4017
300.000	0.6546	1200.000	0.3352	2100.000	0.4130
320.000	0.6484	1220.000	0.3299	2120.000	0.4248
340.000	0.6421	1240.000	0.3248	2140.000	0.4372
360.000	0.6356	1260.000	0.3199	2160.000	0.4502
380.000	0.6290	1280.000	0.3153	2180.000	0.4638
400.000	0.6222	1300.000	0.3108	2200.000	0.4779
420.000	0.6153	1320.000	0.3067	2220.000	0.4926
440.000	0.6083	1340.000	0.3027	2240.000	0.5080
460.000	0.6012	1360.000	0.2990	2260.000	0.5240
480.000	0.5940	1380.000	0.2956	2280.000	0.5405
500.000	0.5867	1400.000	0.2924	2300.000	0.5578
520.000	0.5793	1420.000	0.2895	2320.000	0.5756
540.000	0.5719	1440.000	0.2869	2340.000	0.5941
560.000	0.5643	1460.000	0.2846		
580.000	0.5567	1480.000	0.2826		
600.000	0.5491	1500.000	0.2809		
620.000	0.5414	1520.000	0.2795		
640.000	0.5337	1540.000	0.2784		
660.000	0.5259	1560.000	0.2777		
680.000	0.5182	1580.000	0.2773		
700.000	0.5104	1600.000	0.2773		
720.000	0.5026	1620.000	0.2776		
740.000	0.4948	1640.000	0.2783		
760.000	0.4870	1660.000	0.2793		
780.000	0.4793	1680.000	0.2808		
800.000	0.4715	1700.000	0.2826		
820.000	0.4639	1720.000	0.2848		
840.000	0.4562	1740.000	0.2874		
860.000	0.4486	1760.000	0.2905		
880.000	0.4411	1780.000	0.2939		
900.000	0.4336	1800.000	0.2978		

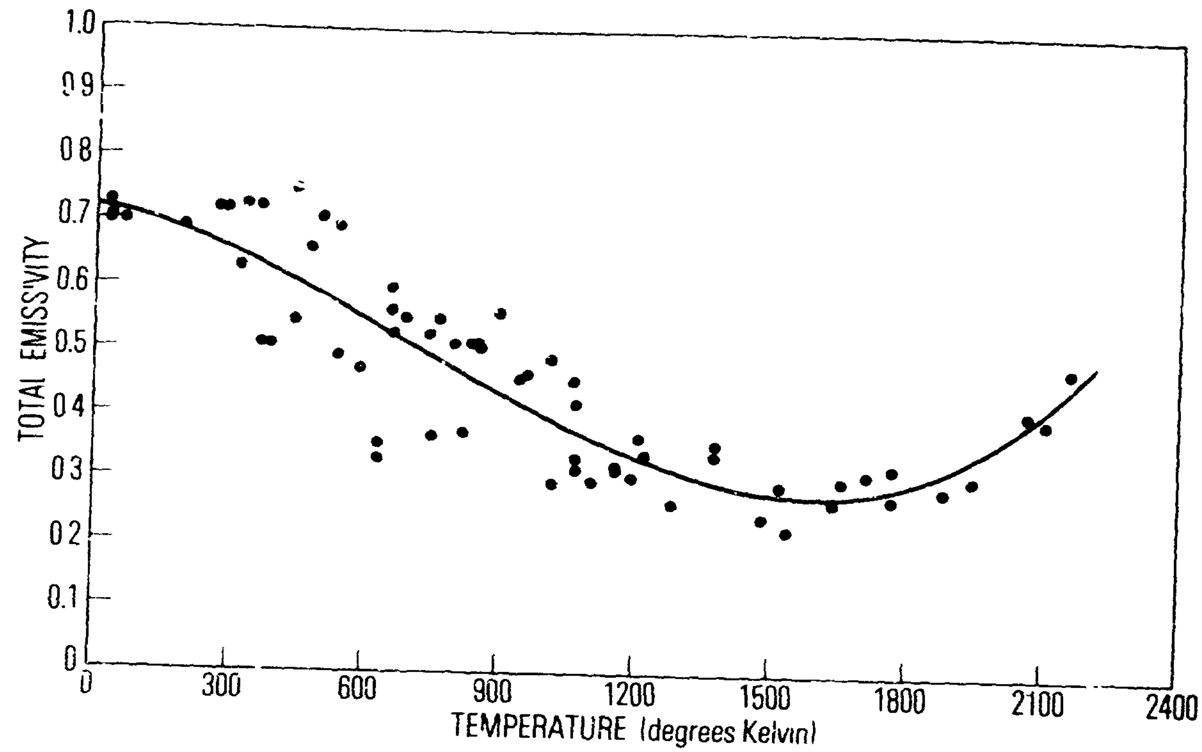


Figure I-3.4 The Total Emissivity of Polycrystalline Magnesium Oxide as a Function of Temperature

I-3.5 Reflectance — Magnesium Oxide

Figure I-3.5a presents the representative curve for single crystal MgO at T = 300°K as measured by Hanna (Ref. 3R-7). Figures I-3.5b and c, measured by Piriou (Ref. 3R-13), are taken as representative for this material for 1080 and 2225°K.

Measurements of the reflectivity of polycrystalline MgO and MgO powder are shown in Figures I-3.5d and I-3.5e, respectively, for T = 300°K. No high temperature measurements were found in the literature. No polycrystalline data beyond 2μ were found, or powder reflectance data at wavelengths longer than 14μ.

Not included in the representative data are the measurements by Arlt (Ref. 3R-2) of the angular spectral reflectivity of MgO powders, which are presented in Section III-3.5.

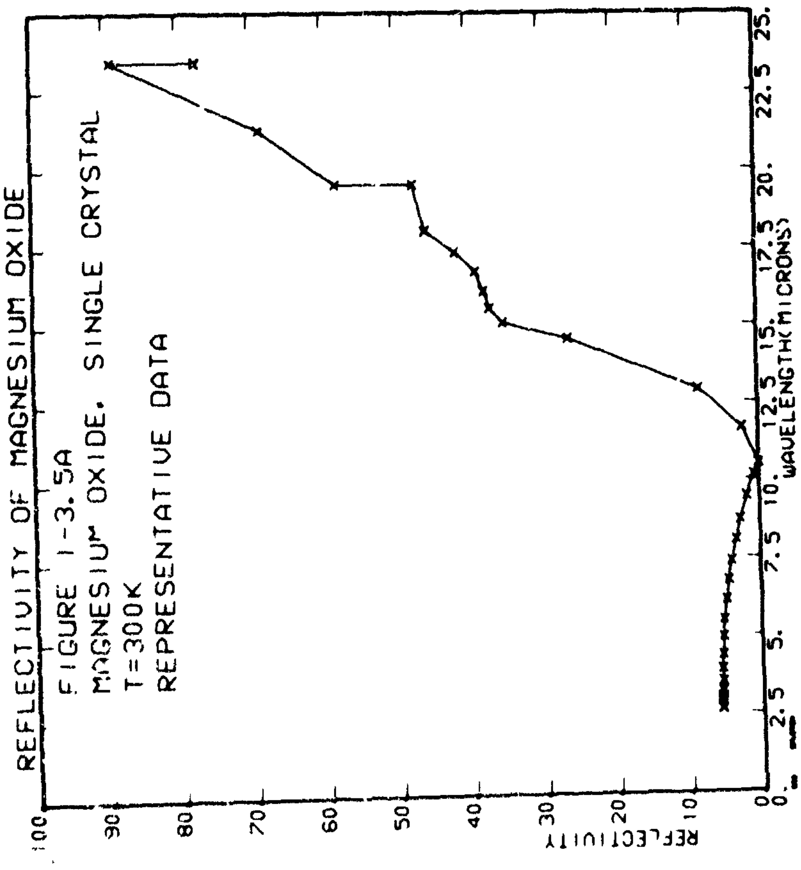
Table I-3.5 Magnesium Oxide Reflectivity — Representative Data

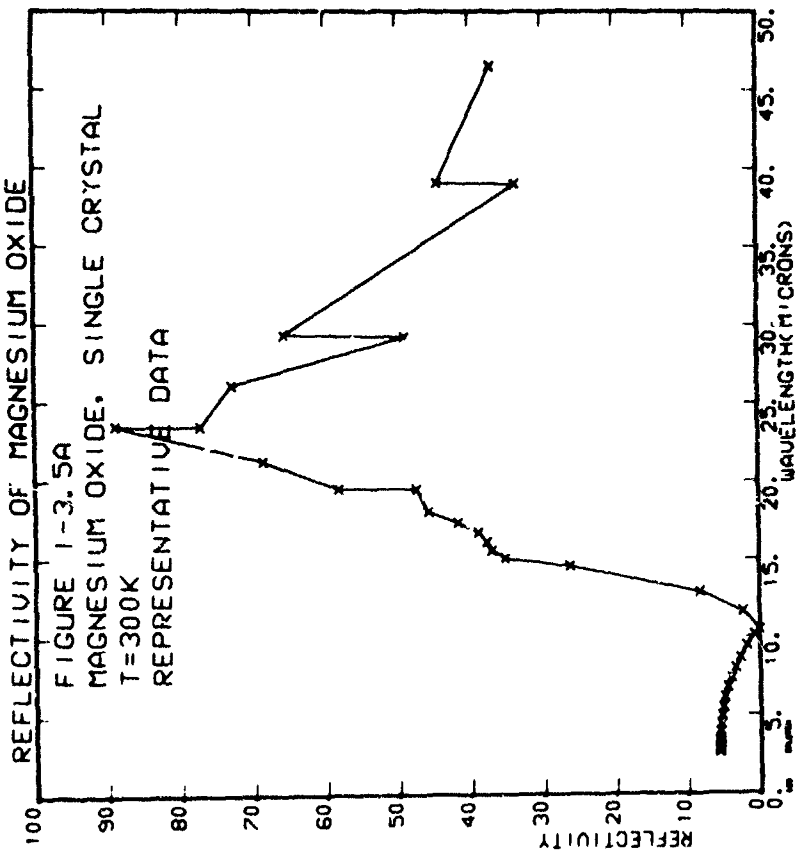
a) Single Crystal Magnesia, T = 300°K

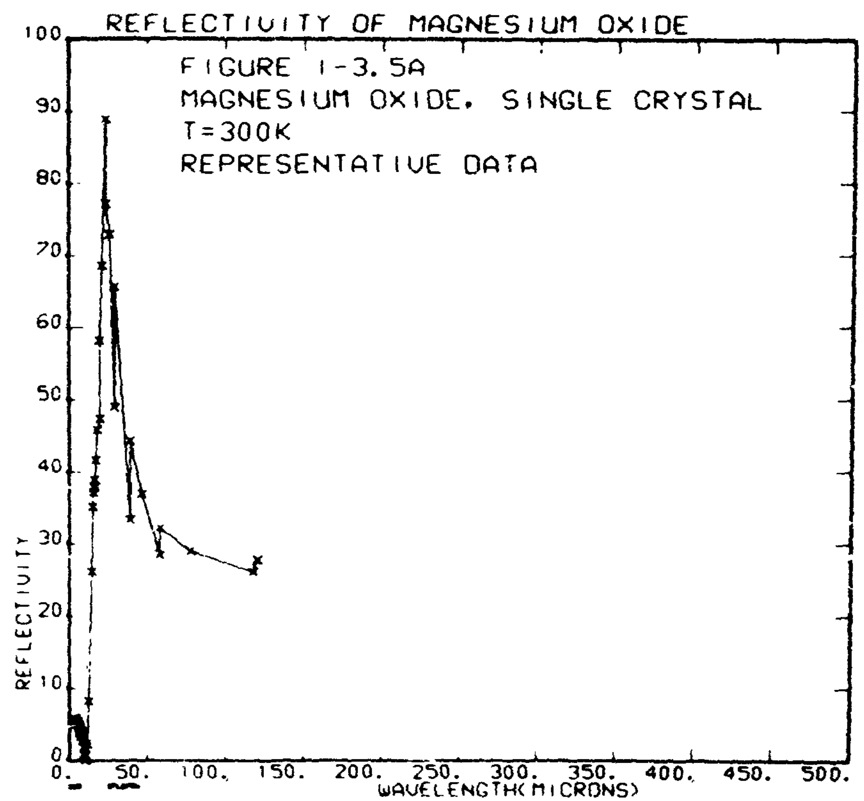
λ	R	λ	R	λ	R
2.654	5.758E+00	2.876	5.758E+00	3.023	5.761E+00
3.246	5.709E+00	3.544	5.676E+00	3.924	5.632E+00
4.395	5.557E+00	4.954	5.444E+00	5.499	5.268E+00
6.155	4.941E+00	6.796	4.503E+00	7.414	4.031E+00
8.085	3.463E+00	8.748	2.763E+00	9.470	1.805E+00
10.167	7.191E-01	10.526	5.186E-02	11.595	2.343E+00
12.942	8.201E+00	14.572	2.620E+01	13.894	3.519E+01
15.550	3.710E+01	16.108	3.779E+01	16.734	3.894E+01
17.356	4.169E+01	18.023	4.587E+01	19.530	4.746E+01
19.530	5.820E+01	21.286	6.860E+01	23.466	8.898E+01
23.406	7.725E+01	26.126	7.291E+01	29.208	4.903E+01
29.325	6.577E+01	39.030	3.346E+01	39.046	4.436E+01
46.523	3.695E+01	58.091	2.859E+01	58.307	3.221E+01
77.630	2.900E+01	118.415	2.612E+01	120.922	2.782E+01

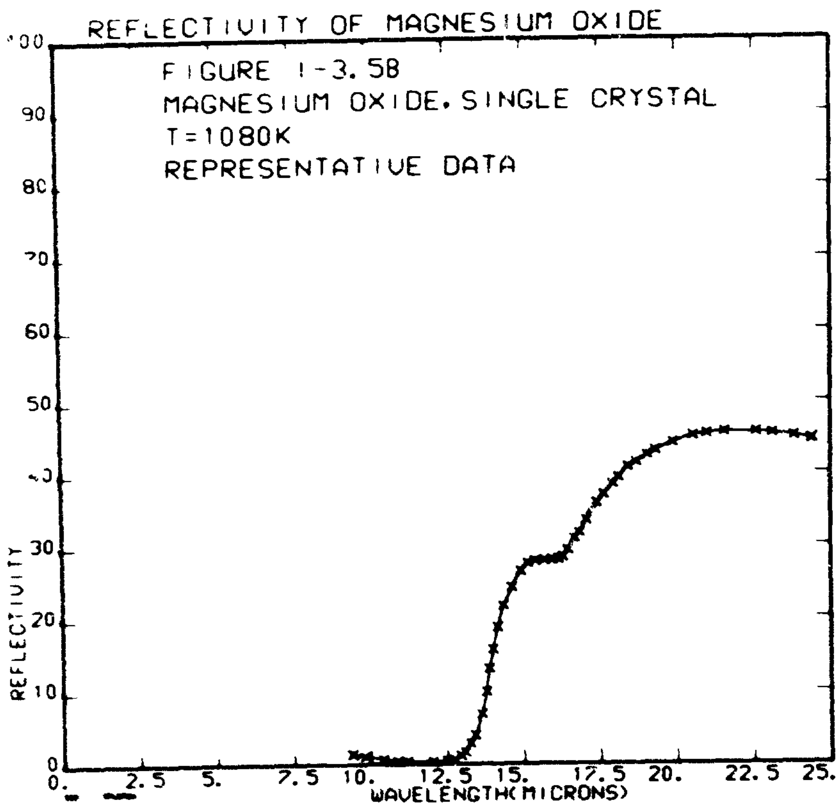
b) Single Crystal Magnesia, T = 1080°K

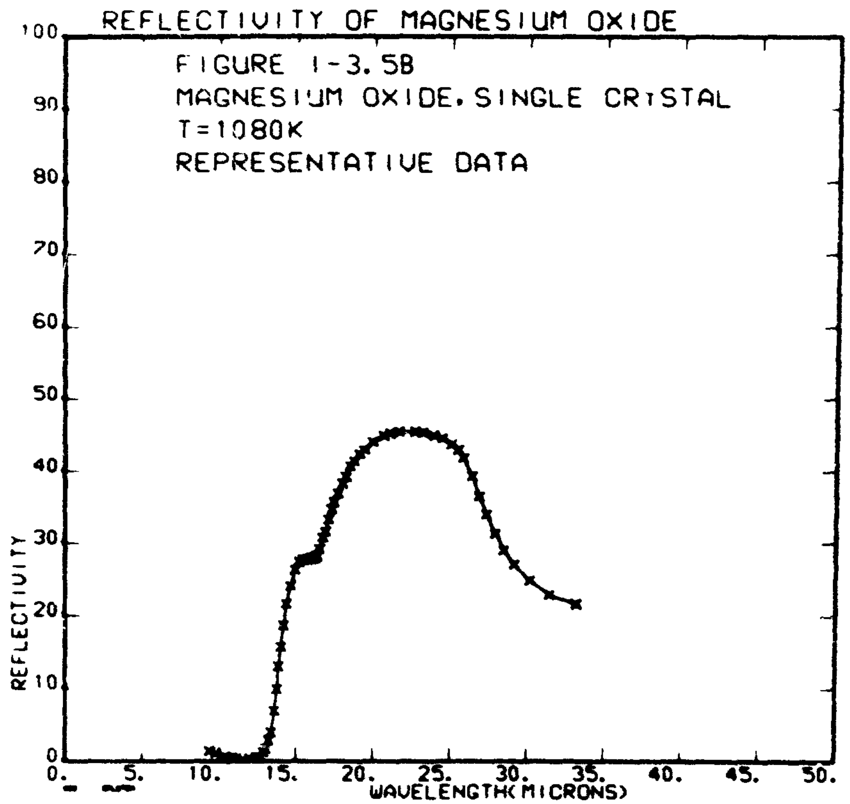
λ	R	λ	R	λ	R
33.210	2.[illegible]E+01	31.472	2.287E+01	31.168	2.485E+01
29.134	2.713E+01	28.435	2.898E+01	27.941	3.129E+01
27.333	3.4[illegible]3E+01	26.664	3.654E+01	26.362	3.931E+01
25.921	4.1[illegible]E+01	25.475	4.302E+01	25.031	4.386E+01
24.432	4.457E+01	23.357	4.564E+01	23.164	4.548E+01
22.640	4.557E+01	21.608	4.55[illegible]E+01	21.034	4.530E+01
20.536	4.[illegible]E+01	19.924	4.413E+01	19.354	4.306E+01
19.391	4.241E+01	18.744	4.146E+01	18.457	4.071E+01
18.155	3.922E+01	17.969	3.838E+01	17.659	3.692E+01
17.444	3.574E+01	17.274	3.471E+01	17.085	3.337E+01
16.358	3.161E+01	16.722	3.082E+01	16.490	2.921E+01
15.307	2.626E+01	16.162	2.792E+01	15.951	2.780E+01
15.712	2.775E+01	15.409	2.779E+01	15.172	2.748E+01
14.930	2.632E+01	14.632	2.[illegible]14E+01	14.350	2.163E+01
14.152	1.659E+01	14.004	1.573E+01	13.891	1.304E+01
13.783	9.971E+00	13.637	6.890E+00	13.418	4.069E+00
13.273	2.926E+00	13.075	1.73[illegible]E+00	12.927	1.281E+00
12.781	5.35[illegible]E-01	12.492	3.350E-01	12.009	3.972E-01
11.135	3.972E-01	10.850	5.269E-01	10.405	7.296E-01
9.333	1.157E+00	9.403	1.451E+00		


REFLECTIVITY OF MAGNESIUM OXIDE
FIGURE I-3.5A
MAGNESIUM OXIDE, SINGLE CRYSTAL
T=300K
REPRESENTATIVE DATA
REFLECTIVITY
100 90 80 70 60 50 40 30 20 10 0
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.


REFLECTIVITY OF MAGNESIUM OXIDE
FIGURE I-3.5A
MAGNESIUM OXIDE, SINGLE CRYSTAL
T=300K
REPRESENTATIVE DATA
REFLECTIVITY
100 90 80 70 60 50 40 30 20 10 0
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.


REFLECTIVITY OF MAGNESIUM OXIDE
FIGURE I-3.5A
MAGNESIUM OXIDE, SINGLE CRYSTAL
T=300K
REPRESENTATIVE DATA
REFLECTIVITY
0
10
20
30
40
50
60
70
80
90
100
0.
50.
100.
150.
200.
250.
300.
350.
400.
450.
500.
WAVELENGTH(MICRONS)


REFLECTIVITY OF MAGNESIUM OXIDE
FIGURE I-3.5B
MAGNESIUM OXIDE, SINGLE CRYSTAL
T=1080K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)


REFLECTIVITY OF MAGNESIUM OXIDE
FIGURE I-3.5B
MAGNESIUM OXIDE, SINGLE CRYSTAL
T=1080K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)

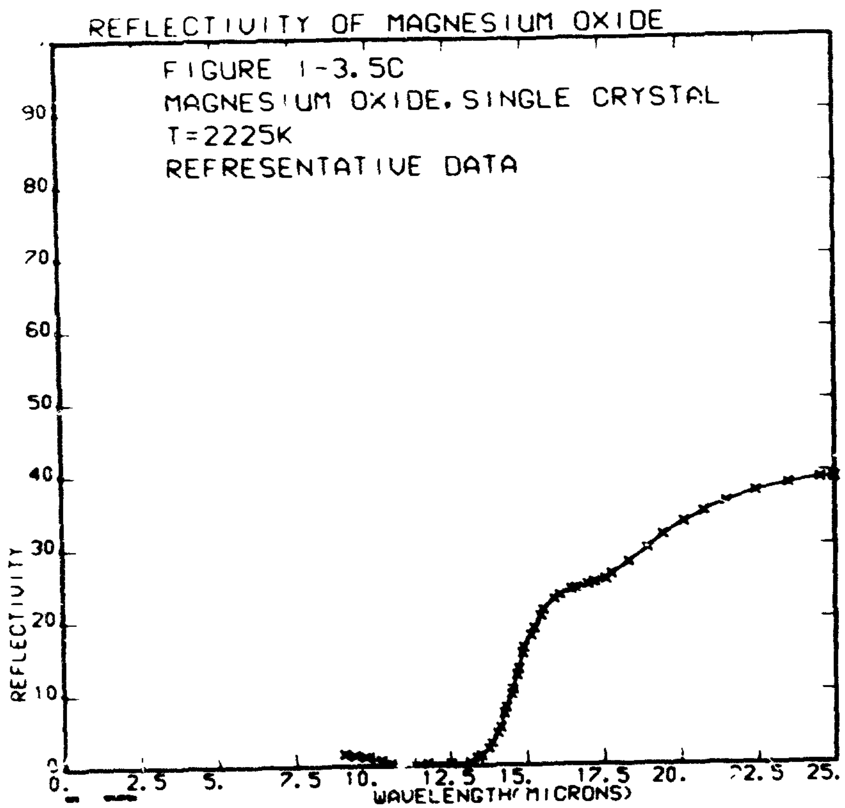
Tab. I-3.5 (Continued)

c) Single Crystal Magnesia, T = 2225°K

λ	R	λ	R	λ	R
33.290	2.415E+01	31.854	2.604E+01	30.978	2.827E+01
30.000	3.033E+01	29.229	3.234E+01	28.495	3.450E+01
27.521	3.635E+01	26.794	3.760E+01	26.154	3.843E+01
25.435	3.837E+01	24.986	3.916E+01	24.546	3.900E+01
23.518	3.833E+01	22.463	3.734E+01	21.516	3.586E+01
20.775	3.457E+01	20.146	3.311E+01	19.460	3.144E+01
18.342	2.955E+01	18.326	2.765E+01	17.783	2.607E+01
17.535	2.538E+01	17.218	2.491E+01	17.020	2.459E+01
16.517	2.417E+01	16.454	2.397E+01	16.094	2.316E+01
15.914	2.259E+01	15.563	2.112E+01	15.470	2.037E+01
15.223	1.875E+01	15.127	1.772E+01	14.917	1.605E+01
14.955	1.522E+01	14.738	1.316E+01	14.679	1.232E+01
14.537	1.031E+01	14.492	9.679E+00	14.322	7.855E+00
14.271	7.012E+00	14.132	5.164E+00	14.044	4.458E+00
13.305	3.016E+00	13.750	2.302E+00	13.512	1.305E+00
13.381	1.054E+00	13.137	4.134E-01	12.508	3.324E-01
11.706	3.324E-01	11.221	3.972E-01	10.824	5.188E-01
10.294	8.137E-01	9.758	1.256E+00	9.400	1.451E+00
9.035	1.678E+00				

d) Polycrystalline Magnesia, T = 300°K

λ	R	λ	R	λ	R	λ	R
.599	8.522E+01	.633	8.546E+01	.657	8.584E+01	.676	8.651E+01
.697	8.832E+01	.714	8.919E+01	.733	8.988E+01	.820	8.986E+01
.923	8.988E+01	1.032	8.988E+01	1.071	9.007E+01	1.116	9.060E+01
1.103	9.117E+01	1.131	9.173E+01	1.247	9.172E+01	1.284	9.201E+01
1.325	9.242E+01	1.397	9.292E+01	1.460	9.358E+01	1.515	9.388E+01
1.552	9.446E+01	1.607	9.482E+01	1.664	9.525E+01	1.706	9.516E+01
1.732	9.537E+01	1.766	9.597E+01	1.788	9.626E+01	1.819	9.607E+01
1.853	9.551E+01	1.837	9.497E+01	1.911	9.446E+01	1.944	9.508E+01
1.971	9.564E+01	1.986	9.630E+01	2.051	9.630E+01		


REFLECTIVITY OF MAGNESIUM OXIDE
FIGURE I-3.5C
MAGNESIUM OXIDE, SINGLE CRYSTAL
T=2225K
REPRESENTATIVE DATA
REFLECTIVITY
0 10 20 30 40 50 60 70 80 90
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
WAVELENGTH(MICRONS)

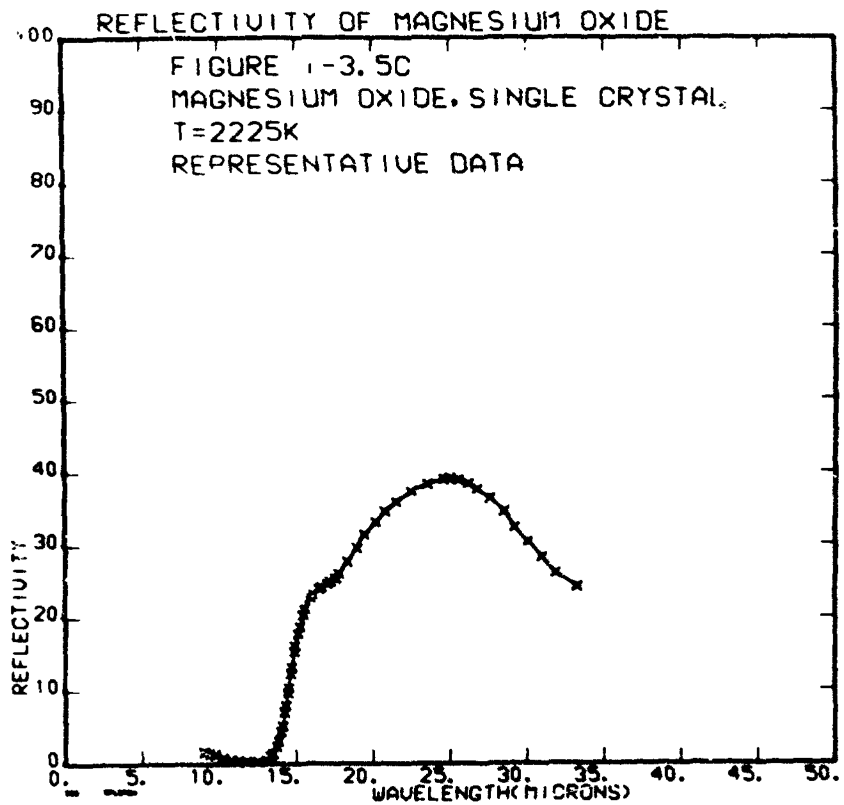
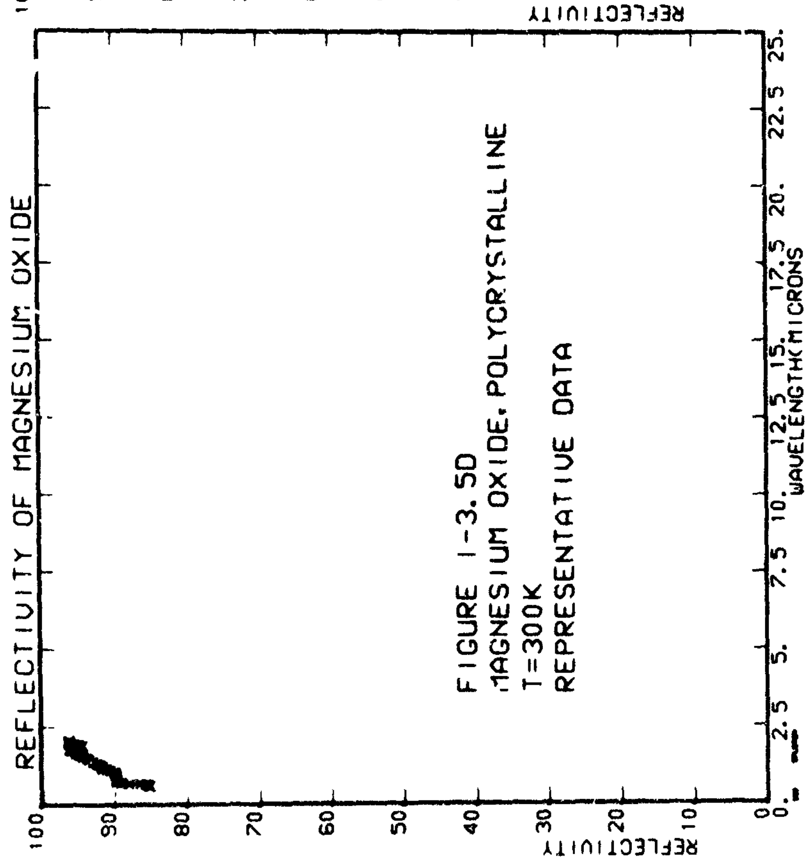
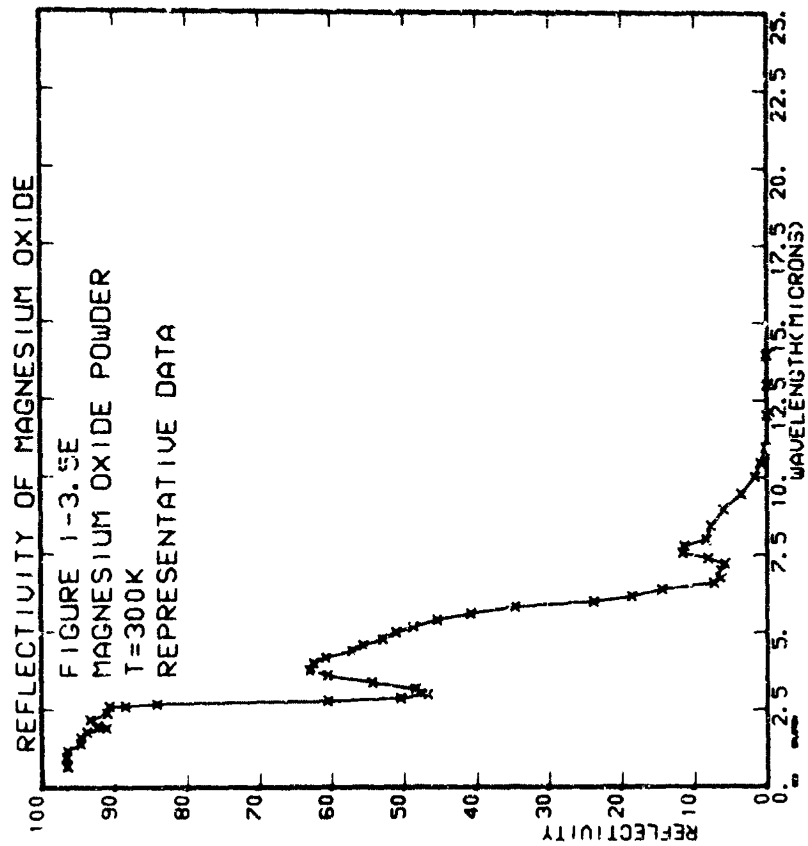

REFLECTIVITY OF MAGNESIUM OXIDE
FIGURE I-3.5C
MAGNESIUM OXIDE, SINGLE CRYSTAL
T=2225K
REPRESENTATIVE DATA
REFLECTIVITY
0 10 20 30 40 50 60 70 80 90 100
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
WAVELENGTH(MICRONS)

Table I-3.5 (Continued)

e) Powdered Magnesia, T = 300°K

λ	R	λ	R	λ	R	λ	R
.686	9.568E+01	.987	9.670E+01	1.183	9.663E+01	1.399	9.479E+01
1.602	9.479E+01	1.785	9.381E+01	1.962	9.117E+01	1.963	9.237E+01
2.183	9.343E+01	2.376	9.099E+01	2.598	9.072E+01	2.614	8.856E+01
2.682	8.411E+01	2.787	5.056E+01	2.882	5.043E+01	3.014	4.676E+01
3.197	4.850E+01	3.393	5.447E+01	3.600	6.057E+01	3.793	6.307E+01
4.006	6.252E+01	4.190	6.088E+01	4.402	5.711E+01	4.597	5.577E+01
4.731	5.29[illegible]E+01	5.021	5.106E+01	5.191	4.873E+01	5.404	4.535E+01
5.021	4.070E+01	5.826	3.461E+01	6.020	2.376E+01	6.197	1.854E+01
6.415	1.441E+01	6.617	7.368E+00	6.783	6.404E+00	7.014	6.345E+00
7.236	5.8[illegible]E+00	7.404	8.155E+00	7.596	1.165E+01	7.810	1.133E+01
8.013	8.320E+00	8.457	7.709E+00	8.985	6.005E+00	9.494	3.502E+00
10.043	1.[illegible]93E+00	10.487	9.753E-01	10.995	1.293E-01	12.038	0.
13.002	0.	13.985	7.051E-02				


REFLECTIVITY OF MAGNESIUM OXIDE
FIGURE I-3.5D
MAGNESIUM OXIDE, POLYCRYSTALLINE
T=300K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100


REFLECTIVITY OF MAGNESIUM OXIDE
FIGURE I-3.5E
MAGNESIUM OXIDE POWDER
T=300K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

I-3.6 Transmittance - Magnesium Oxide

Figure I-3.6a and Table I-3.6a present the representative data for bulk magnesia transmittance at T = 300°K. Data are listed in Section III-3.6 for transmittance at temperatures up to 1270°K, over a limited range of wavelengths. These data are composed of three unnormalized sets taken from Oppenheim (Ref. 3T-12), Piriou (Ref. 3T-13) and Hanna (Ref. 3T-6).

Figure I-3.6b and Table I-3.6b present the data of Sirvastava (Ref. 3T-15) for powdered MgO at T = 300°K. No high temperature powder transmission measurements have been found in the literature.

The structure observed in these transmission spectra is defined in Section I-3.7, where principal lattice frequencies and absorption bands are listed.

Table I-3.6a Bulk Magnesium Oxide Transmittance — Representative Data

1μ to 10μ

λ	T	λ	T	λ	T	λ	T
1.239	8.523E+01	2.297	8.646E+01	3.506	8.758E+01	4.011	8.904E+01
4.953	8.665E+01	5.297	8.663E+01	5.751	8.455E+01	6.001	8.274E+01
5.103	7.953E+01	6.193	7.644E+01	6.503	6.890E+01	6.801	5.572E+01
7.095	4.360E+01	7.400	3.395E+01	7.715	2.385E+01	8.019	1.535E+01
8.549	9.259E+00	8.912	7.039E+00	9.241	4.046E+00		

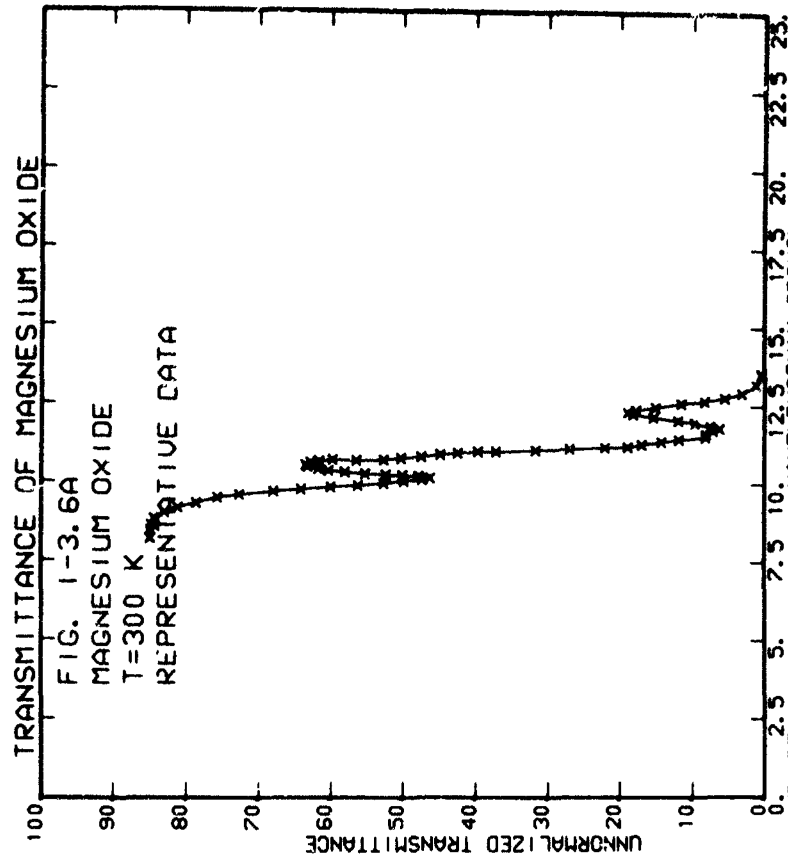
8μ to 12μ

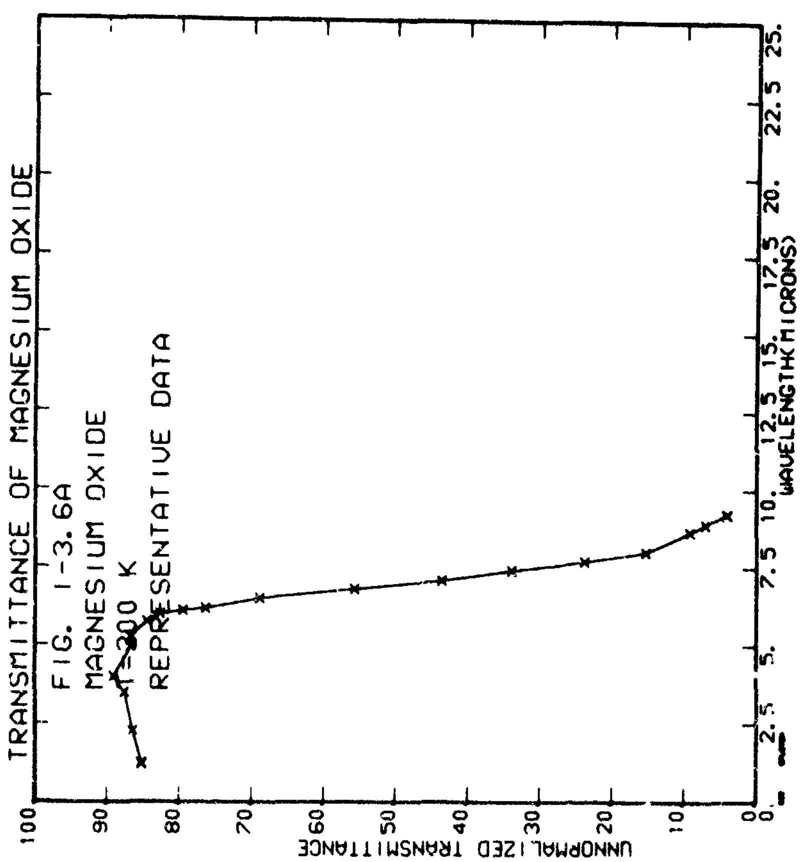
λ	T	λ	T	λ	T
13.536	4.013E-01	13.197	1.229E+00	12.919	3.235E+00
12.772	5.493E+00	12.658	8.352E+00	12.580	1.164E+01
12.456	1.510E+01	12.372	1.781E+01	12.284	1.899E+01
12.228	1.823E+01	12.133	1.543E+01	12.045	1.205E+01
11.948	9.757E+00	11.870	7.550E+00	11.794	6.195E+00
11.711	7.098E+00	11.600	8.151E+00	11.521	8.277E+00
11.437	1.199E+01	11.352	1.430E+01	11.255	1.708E+01
11.195	1.891E+01	11.157	2.212E+01	11.102	2.705E+01
11.058	3.178E+01	11.013	3.725E+01	10.998	3.978E+01
10.954	4.256E+01	10.905	4.490E+01	10.832	4.758E+01
10.783	5.031E+01	10.740	5.272E+01	10.721	5.653E+01
10.723	5.979E+01	10.683	6.178E+01	10.655	6.295E+01
10.571	6.363E+01	10.509	6.333E+01	10.435	6.188E+01
10.377	6.042E+01	10.339	5.811E+01	10.288	5.535E+01
10.250	5.247E+01	10.226	5.011E+01	10.215	4.796E+01
10.159	4.635E+01	10.114	4.740E+01	10.058	4.999E+01
9.983	5.270E+01	9.915	5.631E+01	9.851	6.017E+01
9.778	6.425E+01	9.707	6.807E+01	9.605	7.271E+01
9.501	7.577E+01	9.340	7.878E+01	9.182	8.129E+01
9.044	8.304E+01	8.824	8.452E+01	8.641	8.498E+01
8.463	8.503E+01	8.202	8.503E+01		

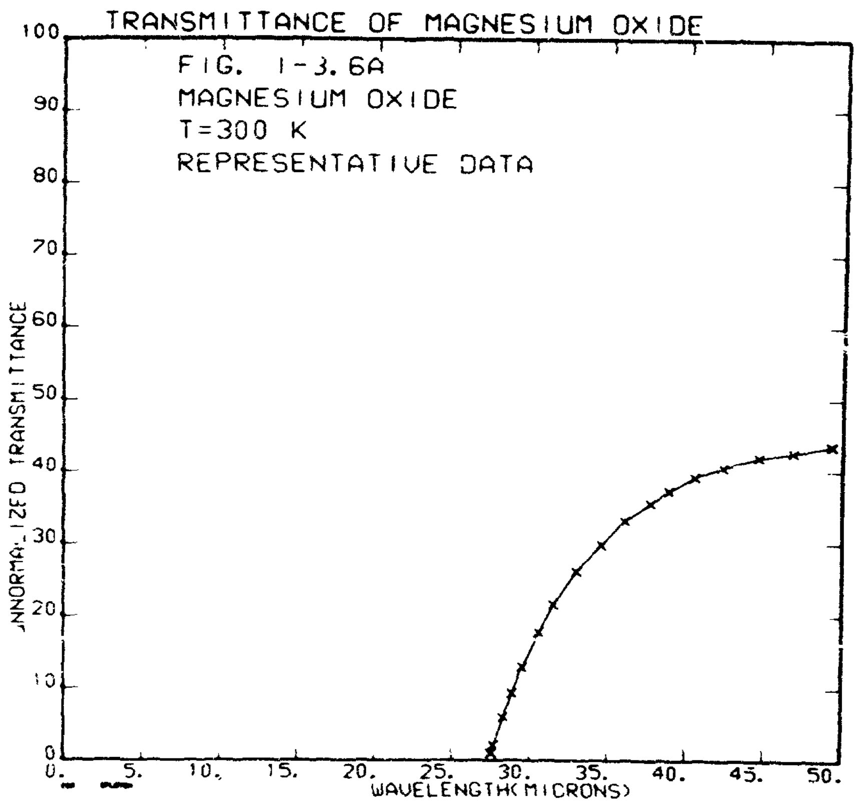
Table I-3.6a (Continued)

27μ to 59μ

λ	T	λ	T	λ	T
59.627	4.607E+01	54.964	[illegible].513E+01	52.291	4.427E+01
49.296	4.366E+01	45.865	4.261E+01	44.653	4.190E+01
42.381	4.046E+01	40.565	3.910E+01	38.930	3.723E+01
37.709	3.554E+01	36.068	3.306E+01	34.594	2.974E+01
32.978	2.615E+01	31.515	2.154E+01	30.575	1.772E+01
29.537	1.297E+01	28.874	9.373E+00	28.299	6.023E+00
27.723	2.117E+00	27.591	1.069E+00		


TRANSMITTANCE OF MAGNESIUM OXIDE
FIG. I-3.6A
MAGNESIUM OXIDE
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF MAGNESIUM OXIDE
FIG. I-3.6A
MAGNESIUM OXIDE
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF MAGNESIUM OXIDE
FIG. I-3.6A
MAGNESIUM OXIDE
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
0 10 20 30 40 50 60 70 80 90 100
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
WAVELENGTH(MICRONS)

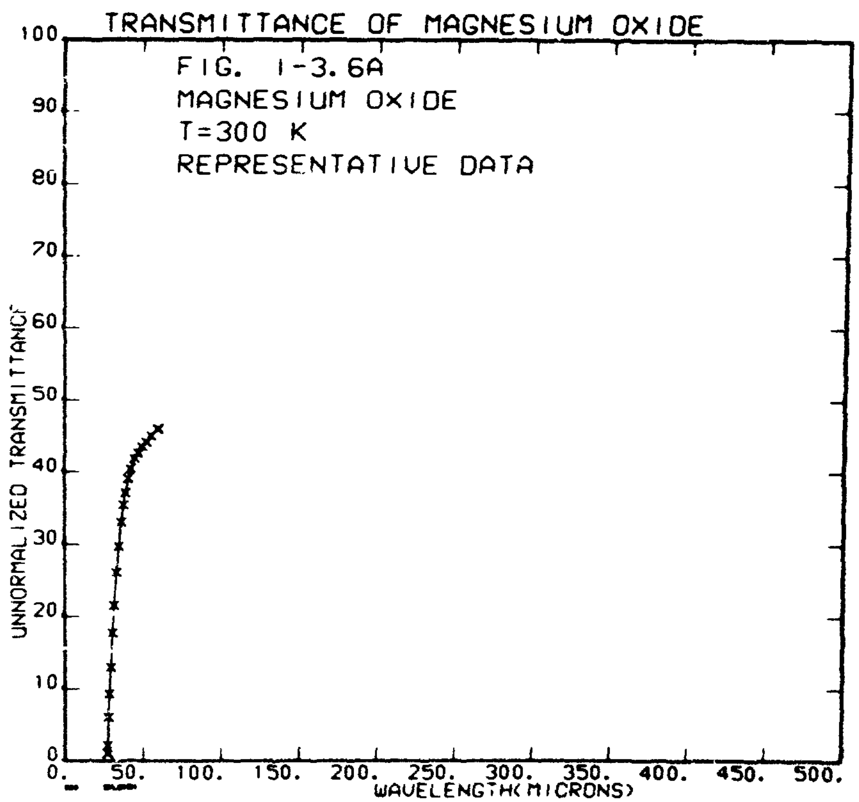
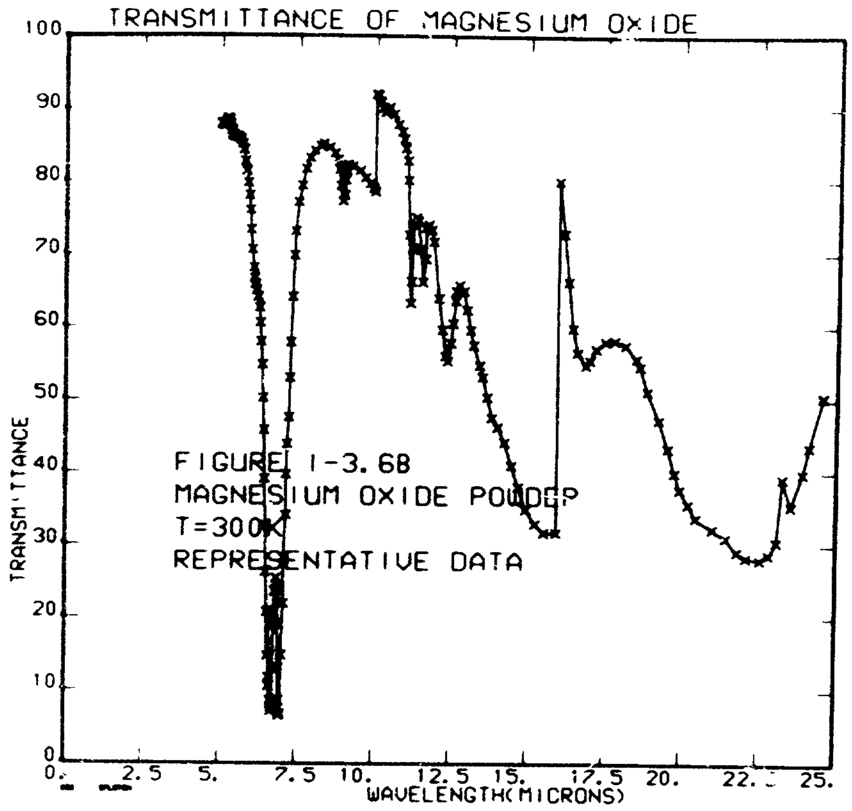

TRANSMITTANCE OF MAGNESIUM OXIDE
FIG. I-3.6A
MAGNESIUM OXIDE
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
0 10 20 30 40 50 60 70 80 90 100
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
WAVELENGTH(MICRONS)

Table I-3.6b Powdered Magnesium Oxide Transmittance – Representative Data

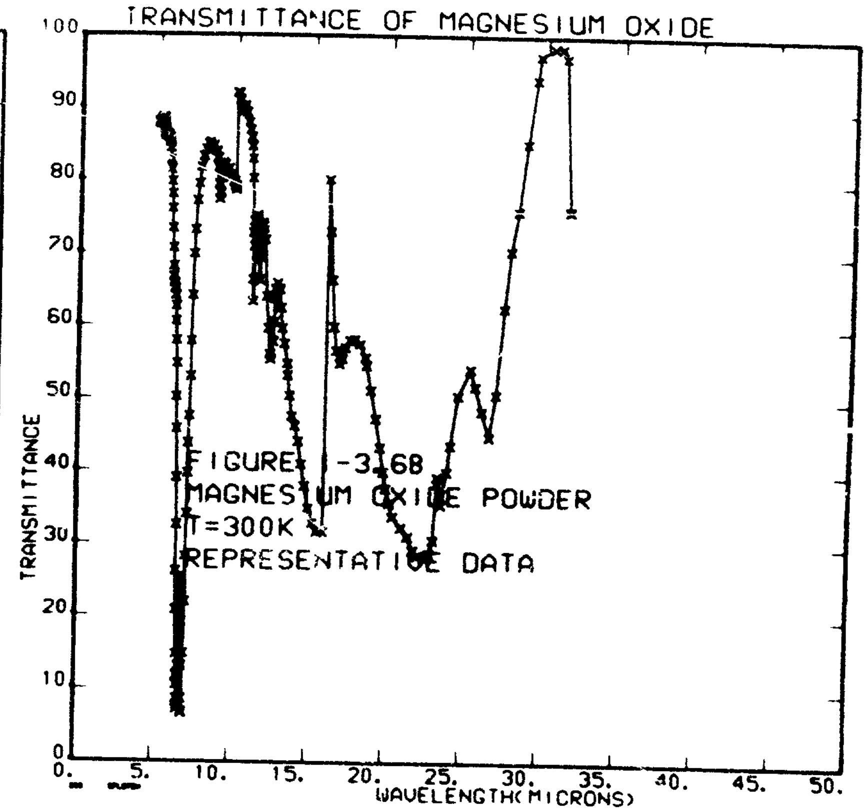
λ	T	λ	T	λ	T
5.005	8.804E+01	5.044	8.794E+01	5.072	8.788E+01
5.103	8.797E+01	5.143	8.843E+01	5.196	8.871E+01
5.236	8.851E+01	5.272	8.792E+01	5.299	8.715E+01
5.333	8.657E+01	5.367	8.626E+01	5.468	8.626E+01
5.538	8.617E+01	5.605	8.582E+01	5.659	8.524E+01
5.706	8.441E+01	5.760	8.288E+01	5.807	8.147E+01
5.853	7.966E+01	5.898	7.815E+01	5.926	7.613E+01
5.959	7.345E+01	6.016	7.076E+01	6.050	6.823E+01
6.083	5.677E+01	6.121	6.593E+01	6.169	6.514E+01
6.215	5.424E+01	6.249	6.277E+01	6.292	6.066E+01
6.320	5.803E+01	6.355	5.485E+01	6.392	5.026E+01
6.429	4.577E+01	6.459	3.899E+01	6.501	3.257E+01
6.539	2.619E+01	6.579	2.073E+01	6.619	1.471E+01
6.646	2.036E+01	6.658	1.175E+01	6.665	1.053E+01
6.714	8.646E+00	6.744	7.170E+00	6.761	7.778E+00
6.765	1.306E+01	6.815	1.901E+01	6.839	2.349E+01
6.888	2.529E+01	6.918	2.371E+01	6.943	1.908E+01
6.971	1.308E+01	6.989	8.594E+00	7.016	6.528E+00
7.043	6.875E+00	7.069	1.485E+01	7.098	2.196E+01
7.113	2.616E+01	7.148	3.404E+01	7.159	3.963E+01
7.193	4.334E+01	7.228	4.755E+01	7.258	5.304E+01
7.291	5.796E+01	7.328	6.422E+01	7.376	6.993E+01
7.405	7.322E+01	7.510	7.720E+01	7.604	7.954E+01
7.724	8.147E+01	7.865	8.330E+01	8.012	8.437E+01
8.182	8.505E+01	8.294	8.533E+01	8.487	8.484E+01
8.549	8.407E+01	8.762	8.311E+01	8.817	8.171E+01
8.862	7.956E+01	8.941	7.746E+01	8.993	7.820E+01
9.018	8.037E+01	9.047	8.163E+01	9.095	8.240E+01
9.232	8.224E+01	9.469	8.161E+01	9.661	8.068E+01
9.319	7.981E+01	9.925	7.921E+01	9.991	7.879E+01
9.393	9.213E+01	10.056	9.208E+01	10.141	9.115E+01
10.219	9.019E+01	10.296	8.965E+01	10.352	9.009E+01
10.415	9.032E+01	10.556	8.942E+01	10.702	8.806E+01
10.827	8.706E+01	10.912	8.608E+01	10.962	8.476E+01
11.033	8.306E+01	11.070	8.035E+01	11.113	7.289E+01
11.165	6.346E+01	11.194	6.640E+01	11.221	7.107E+01
11.244	7.449E+01	11.347	7.521E+01	11.388	7.475E+01
11.481	7.081E+01	11.569	6.629E+01	11.627	6.956E+01
11.655	7.337E+01	11.723	7.419E+01	11.839	7.354E+01
11.912	7.194E+01	12.093	6.410E+01	12.216	5.977E+01
12.355	5.519E+01	12.391	5.545E+01	12.495	5.796E+01
12.530	6.054E+01	12.643	6.385E+01	12.669	6.511E+01
12.739	6.596E+01	12.899	6.511E+01	13.015	6.250E+01
13.124	5.972E+01	13.245	5.759E+01	13.445	5.480E+01
13.539	5.320E+01	13.675	5.044E+01	13.841	4.751E+01
14.030	4.625E+01	14.255	4.410E+01	14.490	4.091E+01

Table I-3. 6b (Continued)

λ	T	λ	T	λ	T
14.735	3.738E+01	14.953	3.481E+01	15.232	3.285E+01
15.550	3.156E+01	15.957	3.161E+01	15.997	8.026E+01
16.160	7.305E+01	16.302	6.645E+01	16.448	5.998E+01
16.517	5.655E+01	16.893	5.483E+01	17.016	5.554E+01
17.222	5.710E+01	17.519	5.812E+01	17.821	5.828E+01
18.151	5.750E+01	18.515	5.573E+01	18.634	5.464E+01
18.837	5.126E+01	19.259	4.725E+01	19.562	4.332E+01
19.737	3.939E+01	19.961	3.761E+01	20.239	3.565E+01
20.490	3.377E+01	21.036	3.225E+01	21.448	3.099E+01
21.823	2.914E+01	22.129	2.835E+01	22.586	2.800E+01
22.854	2.877E+01	23.099	3.050E+01	23.296	3.920E+01
23.559	3.545E+01	23.939	3.989E+01	24.143	4.364E+01
24.558	[illegible]	25.352	5.424E+01	25.675	5.181E+01
26.125	4.838E+01	26.512	4.483E+01	27.022	5.070E+01
27.460	6.205E+01	27.823	7.055E+01	28.247	7.604E+01
28.794	8.535E+01	29.336	9.411E+01	29.539	9.748E+01
30.444	9.654E+01	30.898	9.854E+01	31.236	9.728E+01
31.625	7.616E+01				



TRANSMITTANCE OF MAGNESIUM OXIDE
FIGURE I-3.68
MAGNESIUM OXIDE POWDER
T=300K
REPRESENTATIVE DATA
TRANSMITTANCE
WAVELENGTH(MICRONS)



TRANSMITTANCE OF MAGNESIUM OXIDE
FIGURE I-3.68
MAGNESIUM OXIDE POWDER
T=300K
REPRESENTATIVE DATA
TRANSMITTANCE
WAVELENGTH(MICRONS)

I-3.7 Classical Oscillator Frequency and Observed Absorption Peaks of MgO

These data were compiled from Gourley (Ref. 3T-4), Piriou (Ref. 3T-13), Srivastava (Ref. 3T-15), and Saksena (Ref. 3R-15). Redundant measurements or calculations have not been removed.

λ (μ)	ν (cm^{-1})	Comments	Reference
27.36	365.5	T=77°K, med. strength	3T-13
27.03	370	2-phonon band	3T-15
25.26	395.88	principal lattice freq. (calc.)	3R-15
23.81	420	2-phonon band	3T-15
22.47	445	2-phonon band	3T-15
20.41	490	2-phonon band	3T-15
16.95	590	2-phonon band	3T-15
15.87	630	2-phonon band	3T-15
15.55	643	T=77°K	3T-13
15.22	657	IR active mode	3T-4
14.72	670	multiple phonon band	3T-15
14.35	697	IR active mode	3T-4
13.89	720	multiple phonon band	3T-15
13.74	728	IR active mode	3T-4
13.53	739	IR active mode	3T-4
13.51	740	IR active mode	3T-4
13.40	746	IR active mode	3T-4

$\lambda(\mu)$	$\nu(cm^{-1})$	Comments	Reference
13.16	760	multiple phonon band	3T-15
12.82	780	T=77^{O}K, weak	3T-13
12.80	781	IR active mode	3T-4
12.76	784	T=300^{O}K, weak	3T-13
12.69	788	IR active mode	3T-4
12.34	810	2 phonon band	3T-15
12.29	814	IR active mode	3T-4
12.06	821	IR active mode	3T-4
12.17	822	IR active mode	3T-4
12.08	828	T=77^{O}K, weak	3T-13
12.08	828	IR active mode	3T-4
11.82	846	T=300^{O}K, strong	3T-13
11.82	846	IR active mode	3T-4
11.72	853	T=77^{O}K, strong	3T-13
11.63	860	2 phonon band	3T-15
11.63	860	IR active mode	3T-4
11.60	862	T=300^{O}K, strong	3T-13
11.52	868	T=77^{O}K, strong	3T-13
11.31	884	T=77^{O}K, weak	3T-13
11.29	886	IR active mode	3T-4
11.24	890	2 phonon band	3T-15
11.22	891	IR active mode	3T-4
11.19	894	T=300^{O}K, medium	3T-13
11.16	896	T=77^{O}K, medium	3T-13
11.14	898	IR active mode	3T-4

λ (μ)	ν (cm^{-1})	Comments	Reference
10.83	923	IR active mode	3T-4
10.80	926	T=300°K, medium	3T-13
10.74	931	T=77°K, medium	3T-13
10.71	934	IR active mode	3T-4
10.60	943	IR active mode	3T-4
10.26	975	multiple phonon band	3T-15
10.18	982	T=300°K, strong	3T-13
10.15	985	IR active mode	3T-4
10.14	986	T=77°K, strong	3T-13
10.00	1000		
9.90	1010	T=300°K, weak	3T-13
9.84	1016	T=77°K, weak	3T-13
9.09 to 9.26	1080 to 1100	T=77°K, 300°K, medium	3T-13
8.97	1115	multiple phonon band	3T-15
8.88	1126	IR active mode	3T-4
8.87	1127	IR active mode	3T-4
8.00 to 8.33	1200 to 1250	T=77°K, 300°K, strong	3T-13
7.25	1380	multiple phonon band	3T-15
7.15	1400	T=77°K, 300°K, medium	3T-13
7.02	1425	multiple phonon band	3T-15
6.76	1480	multiple phonon band	3T-15
6.67	1500	multiple phonon band	3T-15
6.60	1515	multiple phonon band	3T-15
6.10	1640	multiple phonon band	3T-15
5.41	1850	multiple phonon band	3T-15

I-3.8 Conclusions: Areas Needing Further Research

a) Refractive Index – no measurements for powdered MgO at any temperature have been made.

b) Extinction Index – for single crystal MgO and polycrystalline MgO, the region from 55μ to 90μ has been inadequately surveyed. Data for powdered MgO at all temperatures and wavelengths are needed.

c) Spectral Emissivity – room temperature measurements for bulk MgO are needed, and also measurements for powdered MgO over the entire temperature and wavelength ranges.

d) Total Normal Emissivity – no data for powdered MgO have been found.

I-4 ZIRCONIUM DIOXIDE PROPERTIES

I-4.1 Refractive Index, n-Zirconium Dioxide

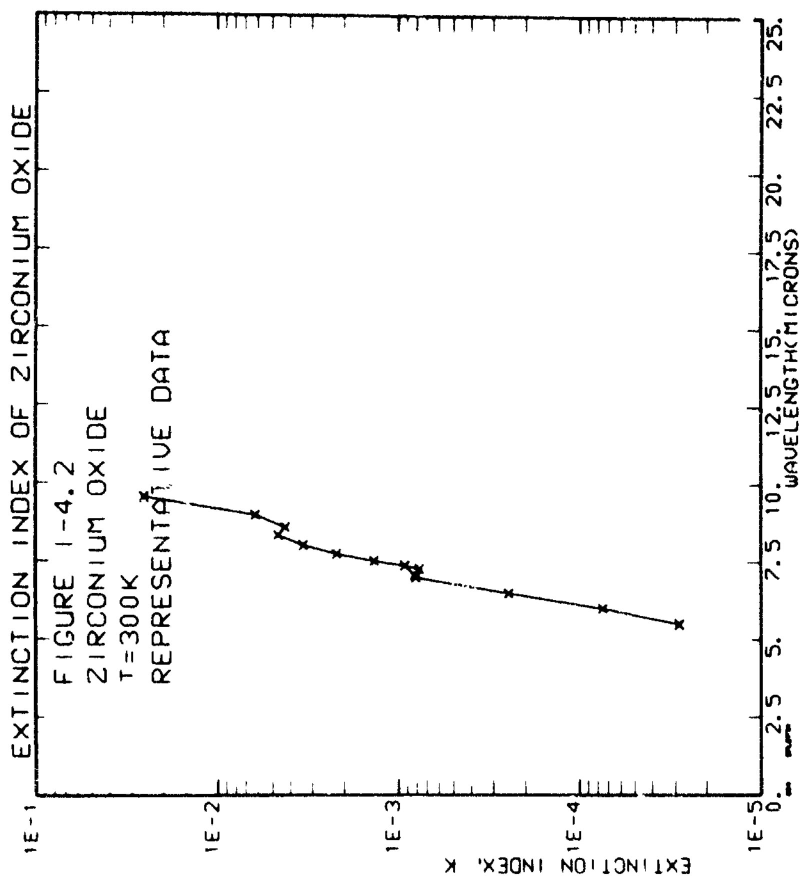
No data on the refractive index of zirconium dioxide were found.

I-4.2 Extinction Index, k-Zirconium Dioxide

The only value of k located in this literature search is that of Piriou (Ref. 4K-1). His data are for monoclinic ZrO_2 from 5μ to 7μ at $300^{o}K$, and are shown in Figure I-4.2 and tabulated in Table I-4.2

Table I-4.2 Zirconium Dioxide Extinction Index — Representative Data

λ	k	λ	k	λ	k	λ	k
5.503	2.853E-05	5.998	7.482E-05	6.496	2.465E-04	6.995	8.025E-04
7.059	8.229E-04	7.255	7.650E-04	7.366	9.250E-04	7.508	1.354E-03
7.741	2.200E-03	8.011	3.340E-03	8.345	4.614E-03	8.587	4.206E-03
8.996	6.174E-03	9.556	2.544E-02				


EXTINCTION INDEX OF ZIRCONIUM OXIDE
FIGURE I-4.2
ZIRCONIUM OXIDE
T=300K
REPRESENTATIVE DATA
EXTINCTION INDEX, K
1E-1
1E-2
1E-3
1E-4
1E-5
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

I-4.3 Spectral Emissivity, $\epsilon(\lambda)$ - Zirconium Dioxide

Figures I-4.3a, b, c show the values of $\epsilon(\lambda)$ at T=1200, 1400, and 1600^{o}K measured by Clark and Moore (Ref. 4SE-5) for cubic-stabilized zirconia. These data are in fair agreement with the other published values of $\epsilon(\lambda)$, which are presented in graphic and tabular form, except that the minimum shown at 2μ was not observed by Blau (Ref 4SE-2). Two possible reasons for this discrepancy are differences in spectrometer bandpass or crystal lattice structure. Clark and Moore (Ref. 4SE-5) described the effects of inadequately stabilized cubic ZrO_2 at 1600^{o}K as being an increased emittance at short wavelengths with a corresponding long wavelength decrease. Figure I-4.3d shows the variation of $\epsilon(\lambda)$ with T for several wavelengths, and suggests a minimum near 1100^{o}K at short wavelengths. The existing data are not sufficiently accurate and/or detailed to adequately determine this variation, however.

It should be noted that in general, emissivity data is dependent on such sample properties as porosity, density, and surface preparation, making application of such data to samples that differ from the original rather uncertain in accuracy. Wherever possible, emissivity data will describe in detail the sample studied.

Table I-4.3 Zirconium Dioxide Spectral Emissivity — Representative Data

a. T = 1200°K

λ	ε	λ	ε	λ	ε	λ	ε
1.000	.103	1.500	.148	2.000	.129	2.500	.131
3.000	.137	3.500	.156	4.000	.187	4.500	.266
5.000	.416	5.500	.537	6.000	.625	6.500	.713
7.000	.791	7.500	.655	8.000	.892	8.500	.876
9.000	.913	9.500	.935	10.000	.949	10.500	.957
11.000	.951	11.500	.964	12.000	.970	12.500	.974
13.000	.972	13.500	.975	14.000	.935	14.500	.893
15.000	.844						

b. T = 1400°K

λ	ε	λ	ε	λ	ε	λ	ε
1.000	.207	1.500	.192	2.000	.172	2.500	.172
3.000	.177	3.500	.188	4.000	.222	4.500	.308
5.000	[illegible]	5.500	.572	6.000	.654	6.500	.744
7.000	.818	7.500	.872	8.000	.902	8.500	.885
9.000	.920	9.500	.942	10.000	.954	10.500	.960
11.000	.955	11.500	.968	12.000	.973	12.500	.977
13.000	.973	13.500	.962	14.000	.938	14.500	.902
15.000	.852						

c. T = 1600°K

λ	ε	λ	ε	λ	ε	λ	ε
1.000	.237	1.500	.259	2.000	.247	2.500	.243
3.000	.244	3.500	.250	4.000	.262	4.500	.356
5.000	.432	5.500	.585	6.000	.676	6.500	.760
7.000	.825	7.500	.875	8.000	.905	8.500	.882
9.000	.919	9.500	.940	10.000	.952	10.500	.957
11.000	.952	11.500	.955	12.000	.968	12.500	.959
13.000	.967	13.500	.955	14.000	.935	14.500	.900
15.000	.850						

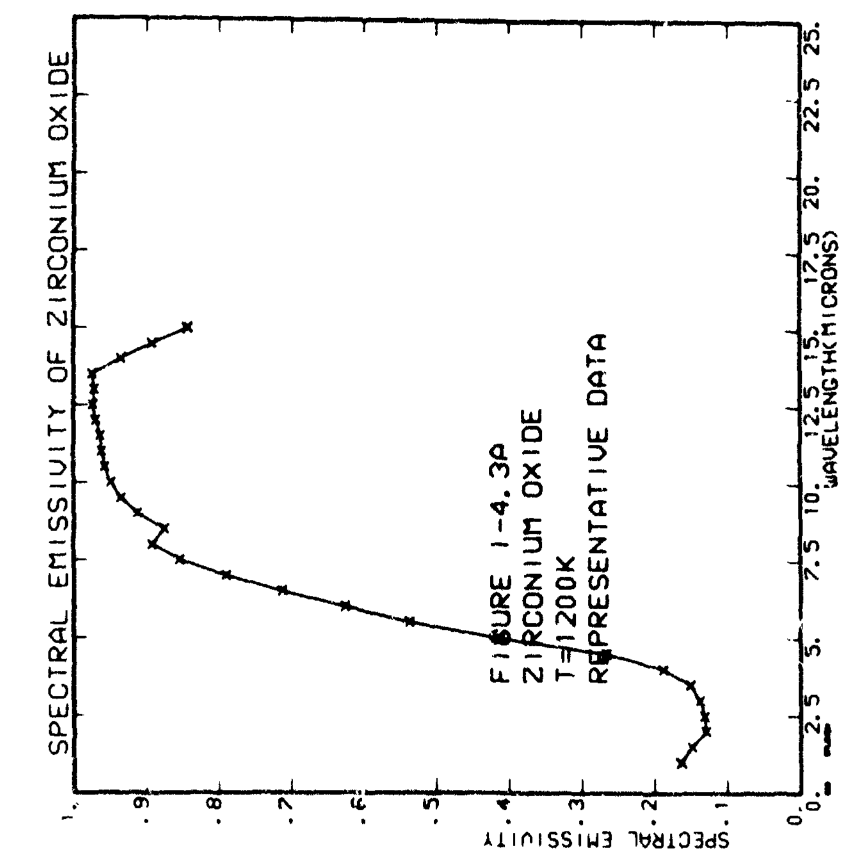


FIGURE I-4.3A
ZIRCONIUM OXIDE
T=1200K
REPRESENTATIVE DATA

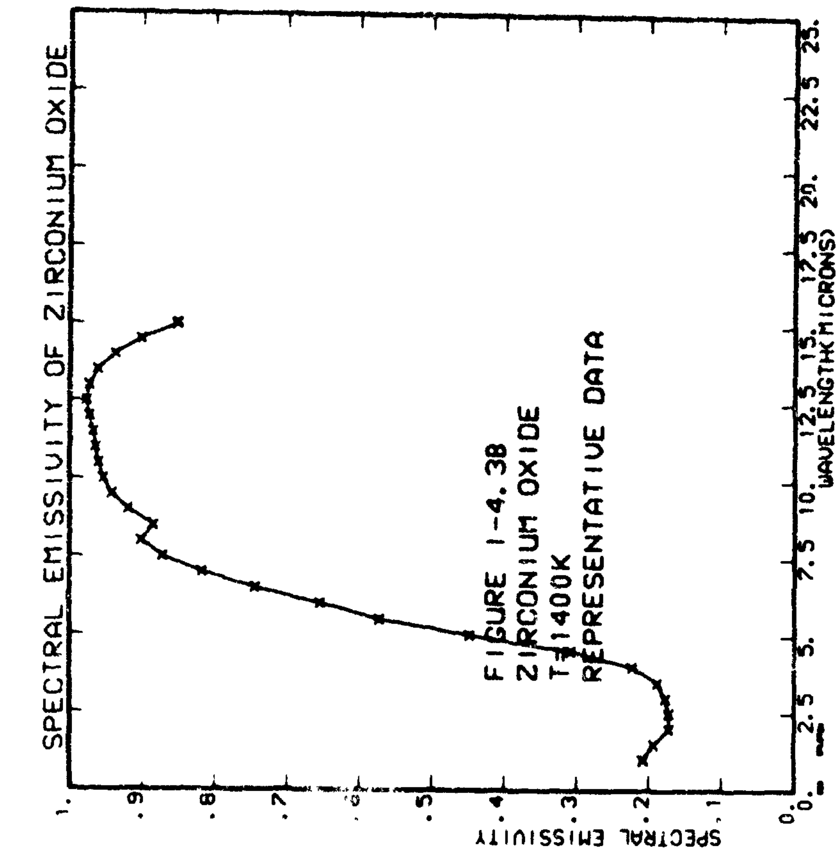
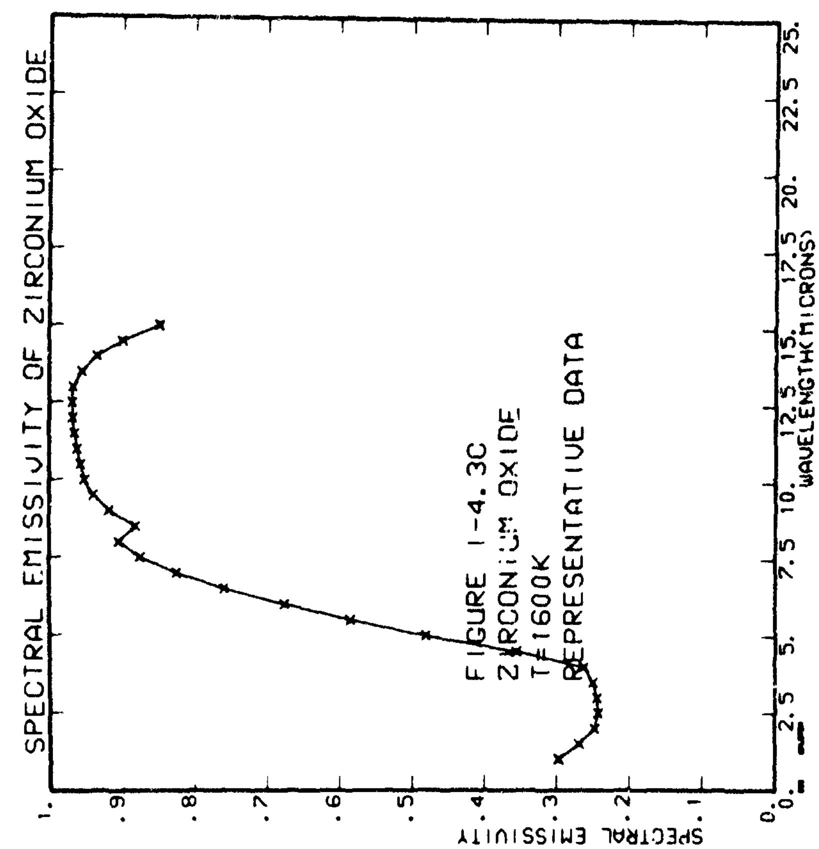


FIGURE I-4.3B
ZIRCONIUM OXIDE
T=1400K
REPRESENTATIVE DATA



SPECTRAL EMISSIVITY OF ZIRCONIUM OXIDE
FIGURE I-4.3C
ZIRCONIUM OXIDE
T=1600K
REPRESENTATIVE DATA
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

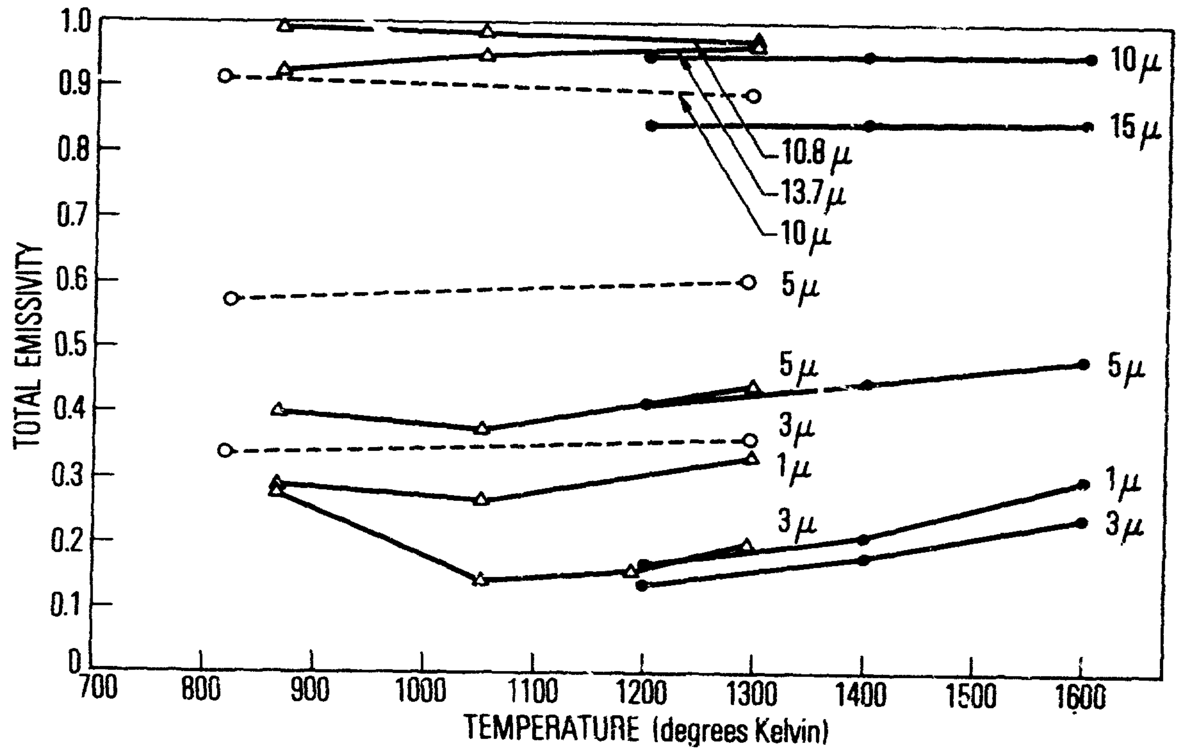


Figure I-4.3d. Variation of ε(λ) With Temperature. Closed Circles are Clark (Ref. 4SE-5), Open Circles are Blau (Ref. 4SE-2), and Triangles are Backhund (Ref. 4SE-1).

I-4.4 Total Normal Emittance: ϵ(T)—Zirconium Dioxide

Four sets of total normal emittance measurements for zirconia either pure or in calcia- or magnesia-stabilized forms have been found in the literature, and are in good agreement. The experimental error limit of $\pm$ 0.05 in ϵ(T) as reported by Hedge (Ref. 4TE-1) is probably representative of all the data. Figure I-4.4 shows all the experimental data points and a fitted third-order polynomial curve, which is tabulated in Table I-4.4.

ϵ(T) varies from approximately 0.8 at 50°K through an apparent minimum of about 0.4 between 1100 and 1600°K, to over 0.5 at 2500°K. No explanation of the minimum has been found in the literature.

All digitized data in the tables in Section III-4.4 were transcribed directly from the experimental points shown explicitly in the literature, not from fitted curves.

Table I-4.4a Representative Values of $\varepsilon(T)$ of Zirconia to 2400°K, Obtained from a Third-Order Polynominal fit to all Experimentally Measured Points

T(°K)	ε(T)	T(°K)	ε(T)	T(°K)	ε(T)
0.000	.8463	900.000	.4437	1800.000	.4319
20.000	.8329	920.000	.4395	1820.000	.4354
40.000	.8193	940.000	.4356	1840.000	.4390
60.000	.8058	960.000	.4318	1860.000	.4428
80.000	.7928	980.000	.4282	1880.000	.4467
100.000	.7799	1000.000	.4247	1900.000	.4508
120.000	.7672	1020.000	.4215	1920.000	.4550
140.000	.7548	1040.000	.4185	1940.000	.4594
160.000	.7426	1060.000	.4156	1960.000	.4639
180.000	.7306	1080.000	.4129	1980.000	.4685
200.000	.7188	1100.000	.4104	2000.000	.4733
220.000	.7073	1120.000	.4081	2020.000	.4782
240.000	.6960	1140.000	.4060	2040.000	.4833
260.000	.6849	1160.000	.4041	2060.000	.4885
280.000	.6740	1180.000	.4023	2080.000	.4938
300.000	.6634	1200.000	.4007	2100.000	.4993
320.000	.6530	1220.000	.3993	2120.000	.5049
340.000	.6428	1240.000	.3981	2140.000	.5107
360.000	.6329	1260.000	.3971	2160.000	.5165
380.000	.6231	1280.000	.3962	2180.000	.5225
400.000	.6136	1300.000	.3955	2200.000	.5287
420.000	.6043	1320.000	.3950	2220.000	.5349
440.000	.5952	1340.000	.3946	2240.000	.5413
460.000	.5863	1360.000	.3944	2260.000	.5478
480.000	.5777	1380.000	.3944	2280.000	.5545
500.000	.5692	1400.000	.3946	2300.000	.5612
520.000	.5610	1420.000	.3949	2320.000	.5681
540.000	.5530	1440.000	.3954	2340.000	.5751
560.000	.5452	1460.000	.3961	2360.000	.5823
580.000	.5376	1480.000	.3969	2380.000	.5895
600.000	.5302	1500.000	.3979	2400.000	.5959
620.000	.5230	1520.000	.3991		
640.000	.5160	1540.000	.4004		
660.000	.5092	1560.000	.4019		
680.000	.5027	1580.000	.4035		
700.000	.4963	1600.000	.4053		
720.000	.4902	1620.000	.4073		
740.000	.4842	1640.000	.4094		
760.000	.4785	1660.000	.4117		
780.000	.4729	1680.000	.4141		
800.000	.4675	1700.000	.4167		
820.000	.4624	1720.000	.4194		
840.000	.4574	1740.000	.4223		
860.000	.4527	1760.000	.4253		
880.000	.4481	1780.000	.4285		

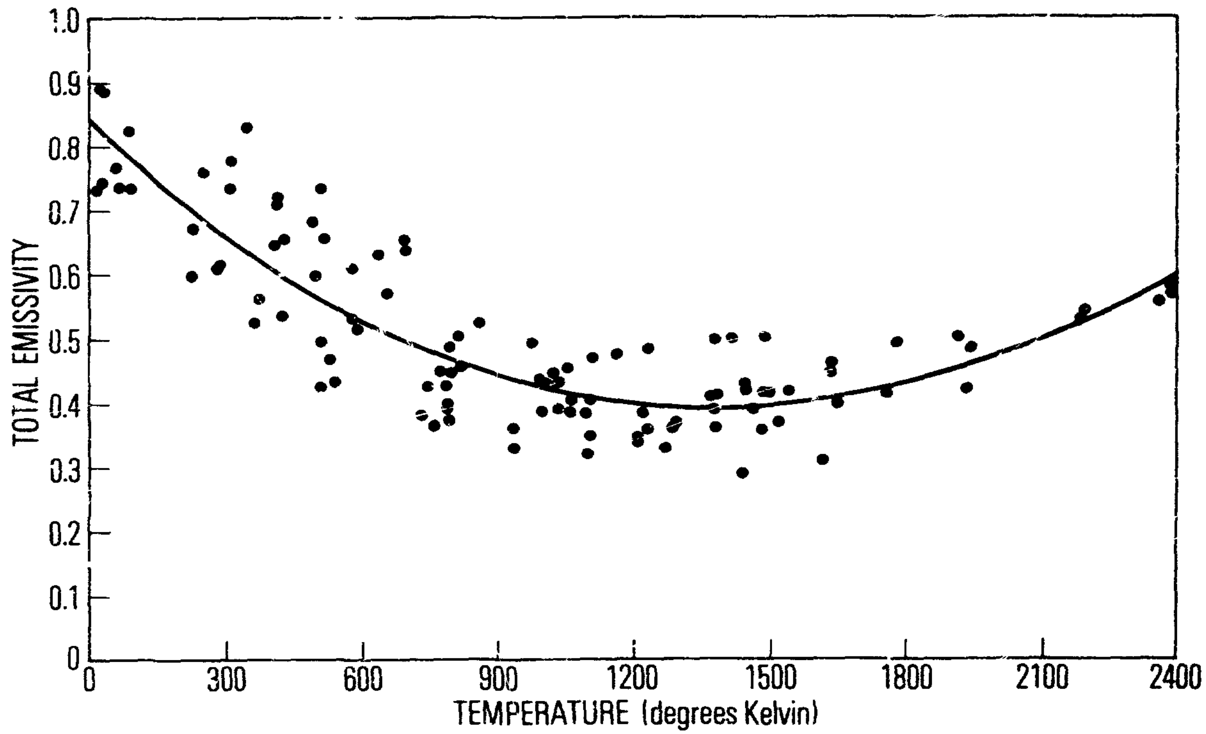


Figure I-4.4 The Total Emissivity of Zirconia as a Function of Temperature — Representative Data

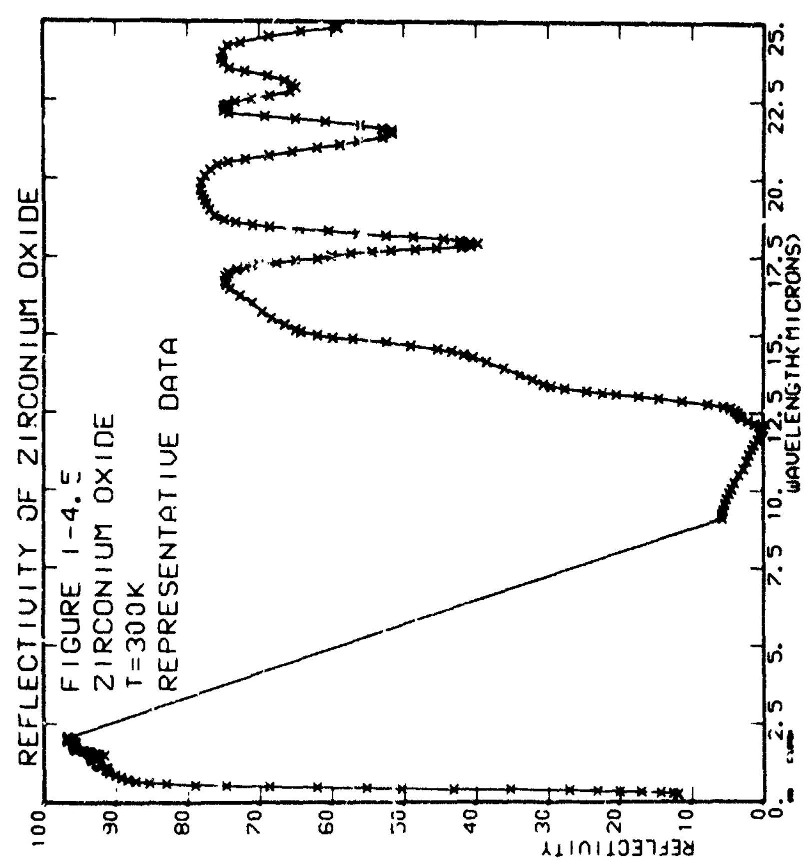
I-4.5 Reflectance - Zirconium Dioxide

Figure I-4.5 shows the data of Clark (Ref. 4R-1) and Piriou (Ref. 4R-3) for monoclinic zirconia at 300°K. Reflectance spectra for the metastable cubic phase may be seen in Section III-4.5. No data from 2.5μ to 9μ were found in the literature, and no data for temperatures other than 300°K were obtained.

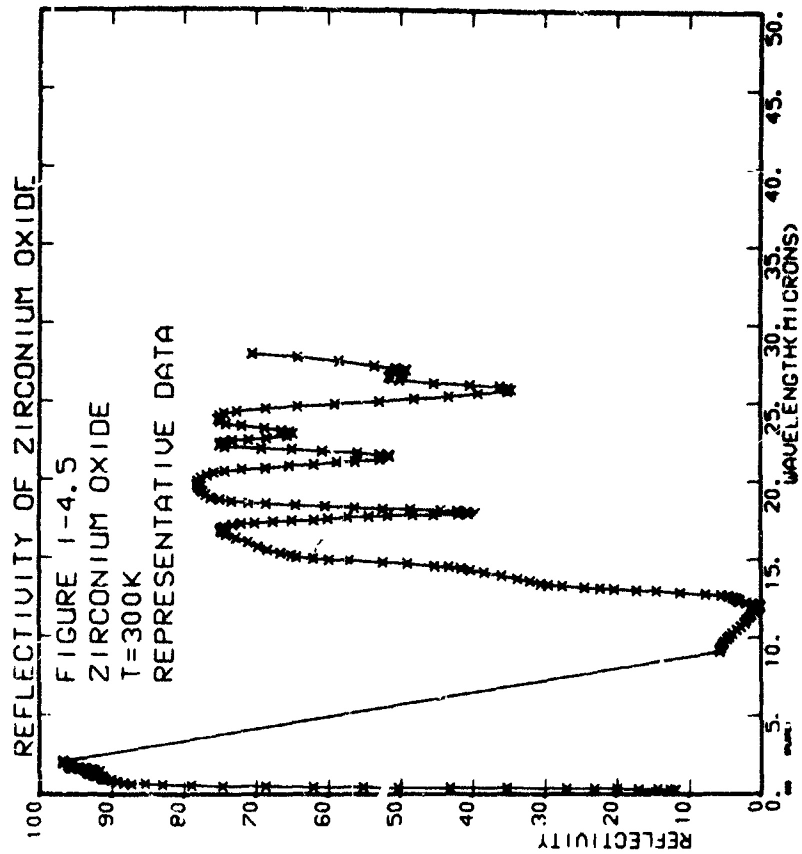
Table I-4 5 Zirconium Dioxide Reflectivity – Representative Data

λ	R	λ	R	λ	R
.260	1.193E+01	.294	1.263E+01	.311	1.443E+01
.332	1.709E+01	.348	2.[illegible]E+01	.364	2.329E+01
.379	2.704E+01	.400	3.536E+01	.421	4.319E+01
.443	5.042E+01	.456	5.527E+01	.473	6.217E+01
.532	6.875E+01	.533	7.470E+01	.564	7.900E+01
.601	8.299E+01	.646	8.547E+01	.686	8.732E+01
.744	8.839E+01	.816	8.936E+01	.896	9.018E+01
.901	9.102E+01	1.032	9.156E+01	1.086	9.123E+01
1.115	9.131E+01	1.148	9.220E+01	1.206	9.264E+01
1.286	9.277E+01	1.353	9.338E+01	1.410	9.334E+01
1.422	9.354E+01	1.483	9.321E+01	1.499	9.266E+01
1.517	9.159E+01	1.529	9.239E+01	1.542	9.308E+01
1.557	9.361E+01	1.666	9.367E+01	1.634	9.393E+01
1.651	9.454E+01	1.680	9.549E+01	1.703	9.579E+01
1.733	9.504E+01	1.787	9.584E+01	1.837	9.580E+01
1.854	9.597E+01	1.884	9.564E+01	1.911	9.562E+01
1.935	9.595E+01	1.963	9.670E+01	2.008	9.672E+01
2.050	9.670E+01	2.097	9.662E+01	9.102	5.754E+00
9.245	5.736E+00	9.363	5.541E+00	9.554	5.361E+00
9.745	5.148E+00	9.899	4.754E+00	10.072	4.459E+00
10.254	4.066E+00	10.499	3.410E+00	10.721	2.803E+00
10.957	2.311E+00	11.154	2.049E+00	11.323	1.689E+00
11.455	1.311E+00	11.647	8.197E-01	11.832	5.246E-01
11.934	2.459E-01	12.018	6.557E-02	12.097	2.131E-01
12.172	1.197E+00	12.272	2.131E+00	12.369	3.016E+00
12.421	3.230E+00	12.522	3.574E+00	12.592	3.918E+00
12.651	4.525E+00	12.713	5.541E+00	12.785	7.721E+00
12.876	1.121E+01	12.958	1.449E+01	13.026	1.730E+01
13.079	2.036E+01	13.124	2.230E+01	13.173	2.457E+01
13.262	2.754E+01	13.337	2.957E+01	13.412	3.364E+01
13.552	3.215E+01	13.711	3.380E+01	13.918	3.602E+01
14.133	3.841E+01	14.279	4.031E+01	14.362	4.166E+01
14.470	4.335E+01	14.542	4.531E+01	14.645	4.901E+01
14.755	5.241E+01	14.859	5.719E+01	14.912	5.993E+01
14.989	6.203E+01	15.084	6.440E+01	15.159	6.510E+01
15.324	6.664E+01	15.525	6.646E+01	15.742	6.969E+01
15.398	7.115E+01	16.266	7.279E+01	16.484	7.427E+01
16.508	7.469E+01	16.711	7.495E+01	16.895	7.481E+01
16.973	7.448E+01	17.096	7.328E+01	17.156	7.208E+01
17.223	7.015E+01	17.360	6.768E+01	17.380	6.565E+01
17.444	6.198E+01	17.529	6.000E+01	17.599	5.735E+01
17.661	5.430E+01	17.711	5.177E+01	17.746	4.838E+01
17.799	4.544E+01	17.805	4.192E+01	17.849	4.054E+01
17.932	3.962E+01	17.964	4.074E+01	18.011	4.219E+01
18.070	4.449E+01	18.137	4.853E+01	18.183	5.246E+01
18.245	5.632E+01	18.327	6.049E+01	18.380	6.453E+01

λ	R	λ	R	λ	R
18.430	6.806E+01	18.511	7.107E+01	18.603	7.339E+01
18.697	7.503E+01	18.805	7.631E+01	19.005	7.703E+01
19.195	7.744E+01	19.318	7.771E+01	19.498	7.807E+01
19.538	7.821E+01	19.871	7.810E+01	20.077	7.768E+01
20.253	7.687E+01	20.430	7.586E+01	20.544	7.437E+01
20.022	7.198E+01	20.737	6.862E+01	20.854	6.544E+01
20.381	6.195E+01	21.097	5.888E+01	21.194	5.520E+01
21.340	5.285E+01	21.455	5.152E+01	21.558	5.162E+01
21.520	5.295E+01	21.722	5.597E+01	21.831	6.084E+01
21.913	6.506E+01	21.986	6.920E+01	22.088	7.432E+01
22.149	7.503E+01	22.302	7.498E+01	22.368	7.446E+01
22.464	7.334E+01	22.534	7.101E+01	22.624	6.859E+01
22.764	6.575E+01	22.901	6.498E+01	23.005	6.547E+01
23.131	6.657E+01	23.280	6.886E+01	23.398	7.206E+01
23.514	7.427E+01	23.686	7.503E+01	23.813	7.536E+01
24.035	7.535E+01	24.230	7.440E+01	24.343	7.260E+01
24.532	6.806E+01	24.675	6.424E+01	24.841	5.915E+01
25.021	5.290E+01	25.166	4.810E+01	25.300	4.335E+01
25.504	3.921E+01	25.663	3.518E+01	25.781	3.469E+01
25.891	3.511E+01	25.953	3.628E+01	26.059	4.030E+01
26.156	4.544E+01	26.381	5.012E+01	26.473	5.126E+01
26.565	5.162E+01	26.677	5.147E+01	26.819	4.970E+01
26.957	4.922E+01	27.014	4.935E+01	27.135	5.671E+01
27.285	5.364E+01	27.593	5.859E+01	27.795	6.424E+01
28.000	7.052E+01				



REFLECTIVITY OF ZIRCONIUM OXIDE
FIGURE I-4.5
ZIRCONIUM OXIDE
T=300K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)



REFLECTIVITY OF ZIRCONIUM OXIDE
FIGURE I-4.5
ZIRCONIUM OXIDE
T=300K
REPRESENTATIVE DATA
REFLECTIVITY
WAVELENGTH(MICRONS)

I-4.6. Transmittance - Zirconium Dioxide

Unnormalized representative data for monoclinic zirconia transmittance are listed in Table I-4.6a and b, and shown in Figures I-4.6a and b. The data from 1μ to 9μ were measured by Piriou (Ref. 4T-6), and from 12μ to 36μ by Baun (Ref. 4T-1). The wavelengths of the absorption bands of ZrO_2 having cubic, tetragonal, strained monoclinic, and monoclinic structures are tabulated in Section I-4.8.

Table I-4.6 Zirconium Dioxide Transmittance-Representative Data

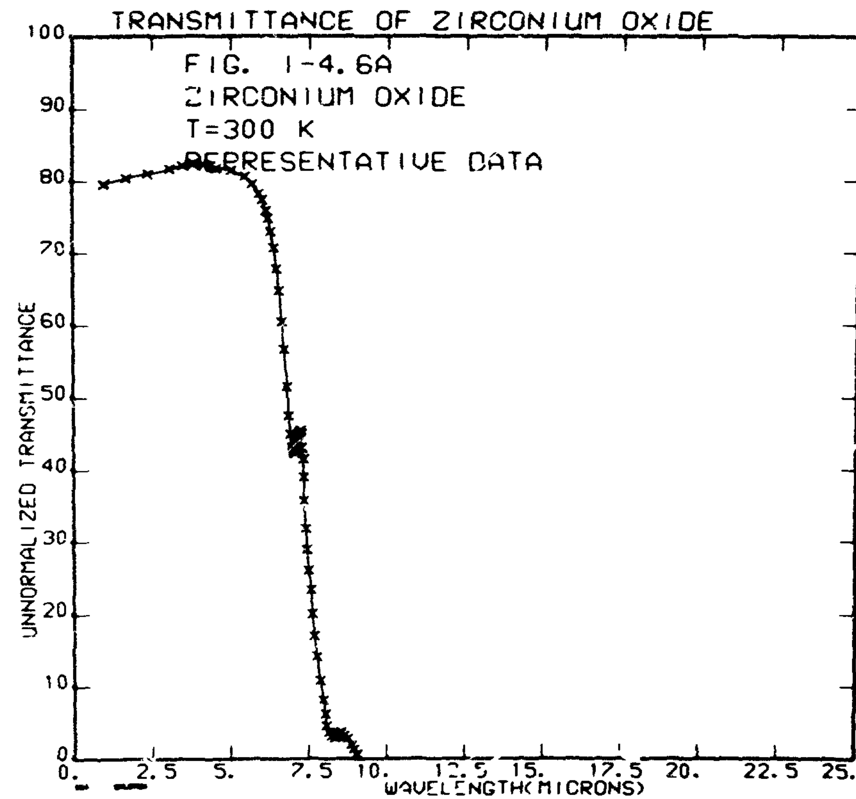
a.

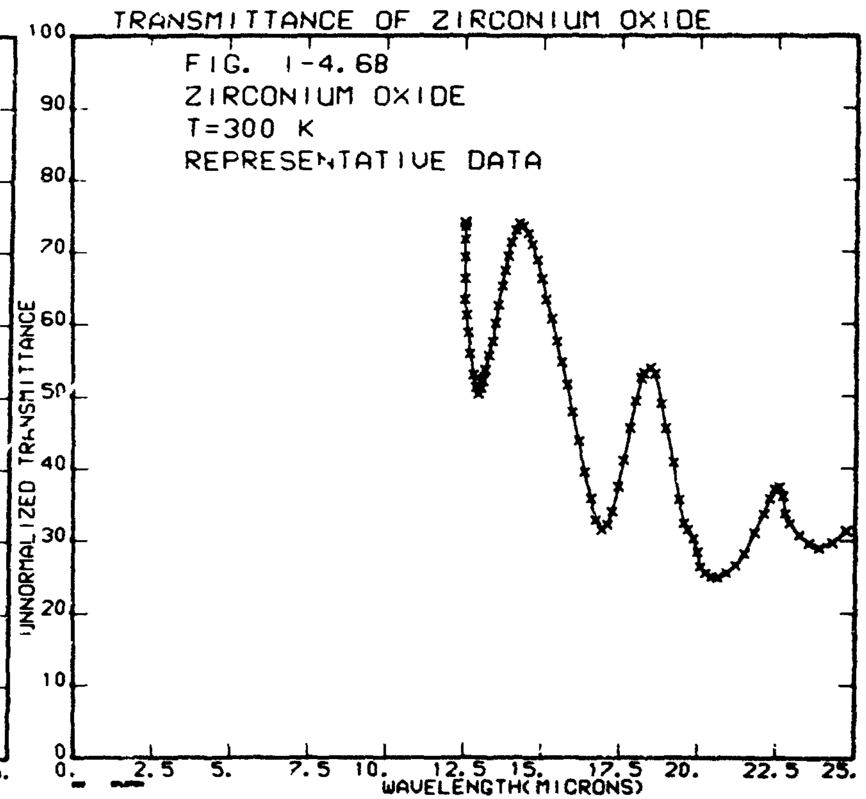
λ	T	λ	T	λ	T	λ	T
1.015	7.968E+01	1.737	8.047E+01	2.378	8.104E+01	3.180	8.174E+01
3.473	8.220E+01	3.838	8.241E+01	4.162	8.230E+01	4.568	8.188E+01
5.041	8.150E+01	5.458	8.062E+01	5.720	7.967E+01	5.918	7.820E+01
5.019	7.743E+01	6.128	7.597E+01	6.196	7.485E+01	6.293	7.308E+01
6.377	7.070E+01	6.460	6.785E+01	6.550	6.480E+01	6.633	6.057E+01
6.721	5.671E+01	6.799	5.154E+01	6.865	4.757E+01	6.920	4.496E+01
6.979	4.315E+01	7.015	4.264E+01	7.056	4.236E+01	7.093	4.259E+01
7.125	4.369E+01	7.159	4.472E+01	7.190	4.513E+01	7.227	4.545E+01
7.255	4.494E+01	7.294	4.305E+01	7.325	4.159E+01	7.334	3.904E+01
7.365	3.574E+01	7.411	3.190E+01	7.456	2.893E+01	7.509	2.619E+01
7.575	2.330E+01	7.635	2.011E+01	7.697	1.702E+01	7.784	1.417E+01
7.892	1.082E+01	7.980	8.188E+00	8.051	6.227E+00	8.087	4.688E+00
8.157	3.759E+00	8.241	3.242E+00	8.341	2.937E+00	8.404	3.137E+00
8.477	3.501E+00	8.563	3.771E+00	8.641	3.242E+00	8.765	2.796E+00
8.878	1.950E+00	8.972	1.386E+00	9.065	6.579E-01		

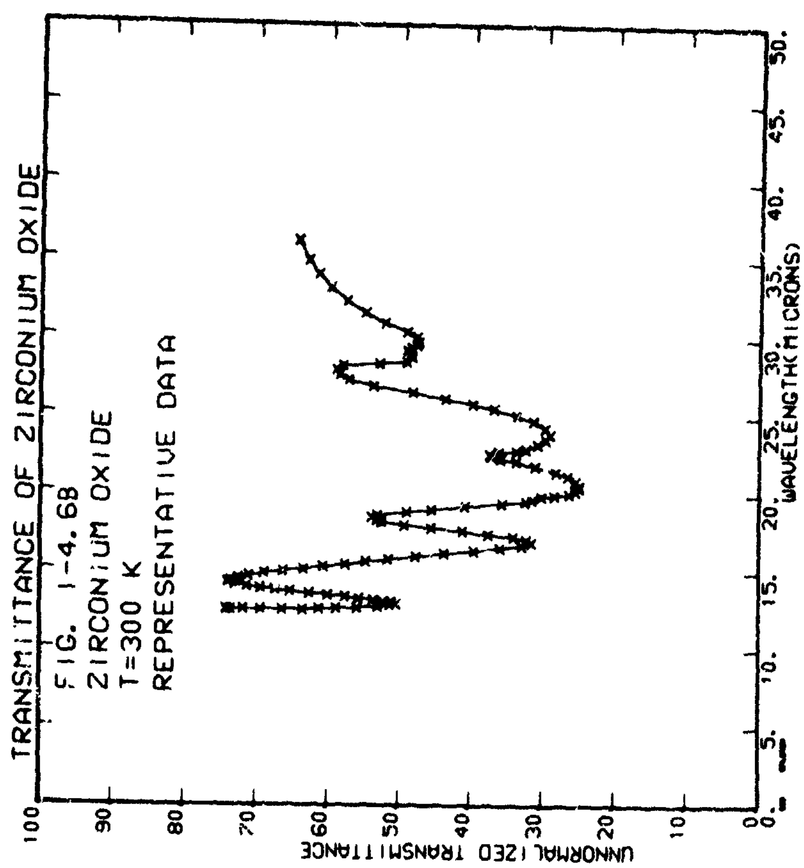
Table I-4.6 (Continued)

b.

λ	R	λ	R	λ	R
12.616	5.388E+01	12.694	5.585E+01	12.778	5.295E+01
12.854	5.121E+01	12.932	5.035E+01	13.017	5.115E+01
13.074	5.227E+01	13.170	5.364E+01	13.283	5.560E+01
13.388	5.763E+01	13.484	6.013E+01	13.586	6.263E+01
13.680	6.531E+01	13.776	6.740E+01	13.879	6.942E+01
13.986	7.135E+01	14.184	7.387E+01	14.246	7.402E+01
14.353	7.367E+01	14.510	7.250E+01	14.668	7.101E+01
14.810	6.894E+01	14.957	6.638E+01	15.114	6.347E+01
15.283	6.075E+01	15.440	5.765E+01	15.601	5.478E+01
15.777	5.164E+01	15.969	4.769E+01	16.152	4.385E+01
16.370	3.957E+01	16.550	3.598E+01	16.727	3.283E+01
16.943	3.142E+01	17.109	3.212E+01	17.265	3.409E+01
17.443	3.756E+01	17.616	4.116E+01	17.814	4.551E+01
17.981	4.930E+01	18.155	5.252E+01	18.247	5.327E+01
18.455	5.393E+01	18.606	5.316E+01	18.801	4.904E+01
18.966	4.556E+01	19.283	4.085E+01	19.397	3.574E+01
19.558	3.232E+01	19.679	3.144E+01	19.871	3.027E+01
19.978	2.840E+01	20.081	2.638E+01	20.265	2.542E+01
20.464	2.494E+01	20.628	2.483E+01	20.939	2.544E+01
21.215	2.658E+01	21.481	2.820E+01	21.808	3.107E+01
22.115	3.374E+01	22.287	3.598E+01	22.442	3.721E+01
22.588	3.741E+01	22.715	3.623E+01	22.786	3.374E+01
22.942	3.229E+01	23.231	3.076E+01	23.529	2.968E+01
23.865	2.907E+01	24.284	2.972E+01	24.731	3.139E+01
25.069	3.374E+01	25.480	3.691E+01	25.757	3.987E+01
26.074	4.383E+01	26.480	4.830E+01	26.862	5.380E+01
27.281	5.725E+01	27.588	5.862E+01	27.920	5.90[illegible]E+01
28.173	5.812E+01	28.334	5.305E+01	28.439	4.926E+01
28.697	4.846E+01	28.956	4.868E+01	29.151	4.914E+01
29.301	4.852E+01	29.456	4.777E+01	29.703	4.751E+01
30.044	4.789E+01	30.369	4.922E+01	30.926	5.230E+01
31.593	5.501E+01	32.332	5.765E+01	33.150	5.995E+01
34.028	6.162E+01	34.942	6.290E+01	36.193	6.436E+01


TRANSMITTANCE OF ZIRCONIUM OXIDE
FIG. I-4.6A
ZIRCONIUM OXIDE
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF ZIRCONIUM OXIDE
FIG. I-4.6B
ZIRCONIUM OXIDE
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF ZIRCONIUM OXIDE
FIG. I-4.6B
ZIRCONIUM OXIDE
T=300 K
REPRESENTATIVE DATA
UNNORMALIZED TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

I-4.7 Observed Absorption Peaks of Zirconium Oxide

These data were compiled from Baun (Ref. 4T-1), Phillippi (Ref. 4T-5) and Piriou (Ref. 4T-6). Redundant data have not been removed.

W(μ)	F(cm^{-1})	Comments	Reference
7.0	1428.6	monoclinic	4T-6
8.1	1234.6	monoclinic	4T-6
12.66±0.16	790±10	monoclinic	4T-6
13.42	745	monoclinic	4T-1
13.51	740	strained monoclinic	4T-5
13.51	740	monoclinic	4T-5
14.29±0.20	700±10	monoclinic	4T-6
16.12	620	shoulder; monoclinic	4T-1
16.13	620	monoclinic	4T-5
17.24	580	strained monoclinic	4T-5
17.25±0.29	580±10	monoclinic	4T-6
17.39	575	tetragonal	4T-5
18.87	530	high intensity, broad; monoclinic	4T-1
19.42	515	monoclinic	4T-5
19.61	510	tetragonal	4T-5
19.61	510	strained monoclinic	4T-5
20.63±0.43	485±10	monoclinic	4T-6
20.83	480	broad minimum; cubic	4T-5
22.22	450	low intensity; monoclinic	4T-1
22.47	445	monoclinic	4T-5
22.49±0.50	445±10	monoclinic	4T-6
22.99	435	tetragonal	4T-5
23.53	425	strained monoclinic	4T-5
23.81	420	low intensity; monoclinic	4T-1
24.10	415	monoclinic	

Table I-4.7 (Continued)

$W(\mu)$	$F(cm^{-1})$	Comments	Reference
24.41±0.59	410±10	monoclinic	4T-6
26.67	375	low intensity; monoclinic	4T-1
26.67	375	monoclinic	4T-5
26.68±0.71	375±10	monoclinic	4T-6
27.40	365	tetragonal	4T-5
27.78	360	shoulder; monoclinic	4T-1
27.78	360	strained monoclinic	4T-5
27.78	360	monoclinic	4T-5
37.04	270	monoclinic	4T-5
37.74	265	strained monoclinic	4T-5
37.88	264	monoclinic	4T-1
42.55	235	monoclinic	4T-5
43.48	230	strained monoclinic	4T-5
44.44	225	monoclinic	4T-1

I-4.8 Conclusions: Areas Needing Further Research

So little is known about zirconia that the research areas open for further work are best defined if that which has been measured is summarized.

a. k: Measured from 5μ to 9μ, 300°K for bulk monoclinic ZrO_2.

b. ε(λ): Measured well from 1μ to 15μ at 1200°K to 1600°K for bulk calcia stabilized zirconia.

c. ε(T): Well defined to 2386°K.

d. Reflectance: Bulk zirconia 0.2μ to 2.2μ and 9μ to 33μ. No data from 2.5μ to 9.0μ. All at 300°K.

e. Transmittance: Bulk monoclinic zirconia, 1μ to 9μ and powdered zirconia 11μ to 33μ. No 9μ to 11μ data of any kind for monoclinic zirconia. One measurement of 9μ to 11μ transmittance for cubic zirconia.

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Bauer, E: 1M-5, 3M-3

Baun, W.L.: 4T-1, 4T-3, 4T-4

Behesti, M.: 2SE-4

Bell, E.E.: 1N-11, 1K-15

Belu, A.: 2M-11

Bent, R.: 2M-1

Beretta, F.: 2M-3

Bergquam, J.B.: 1SE-3

Berthold, G.: 3T-1

Blau, H.H.: 1SE-4, 1SE-5, 1M-6, 2SE-5, 2TE-1, 3SE-1, 3SE-2, 4SE-2, 4SE-3

Blevin, W.R.: 3R-3

Bolle, H.J.: 3R-2

Boyle, W.S.: 2SE-6, 2R-1

Boynton, F.: 2K-1, 2TE-2, 2M-2

Bradford, A.D.: 3N-1

II-5 (Continued)

II-5 (Continued)

II-5 (Continued)

III-1. ALUMINUM OXIDE DATA

III-1.1 Tabulated Refractive Index Data-Aluminum Oxide

Contents:

1N-2: Harris and Piper; films of 200 Å to 2800 Å thickness, T = 300°K (unspecified).

1N-3: Loewenstein; n_o and n_e at T = 1.5 and 300°K, 50μ to 300μ for sapphire.

1N-5: Malitson; n_o of sapphire at T = 297°K.

1N-9: Piriou; sapphire at T = 293°K, 1773°K.

1N-10: Roberts; sapphire, T = 300°K, $\lambda > 100\ \mu$.

1N-11: Russell; sapphire, T = 300°K, $\lambda > 60\ \mu$.

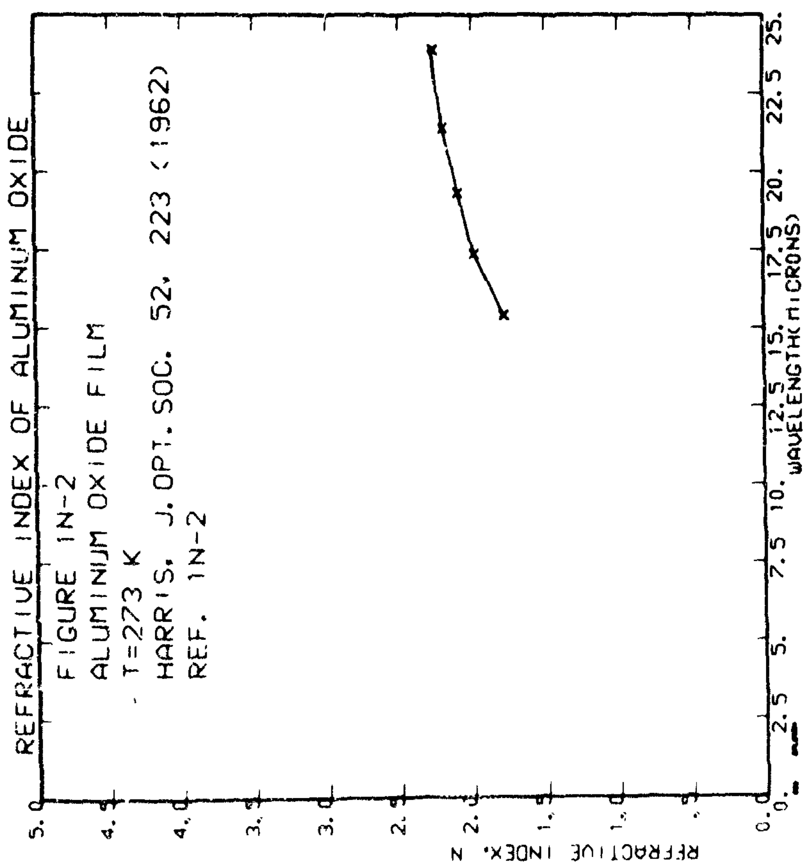
1N-12: Streed; sapphire at T = 300°K an 925°K, alumina powders at T = 300°K.

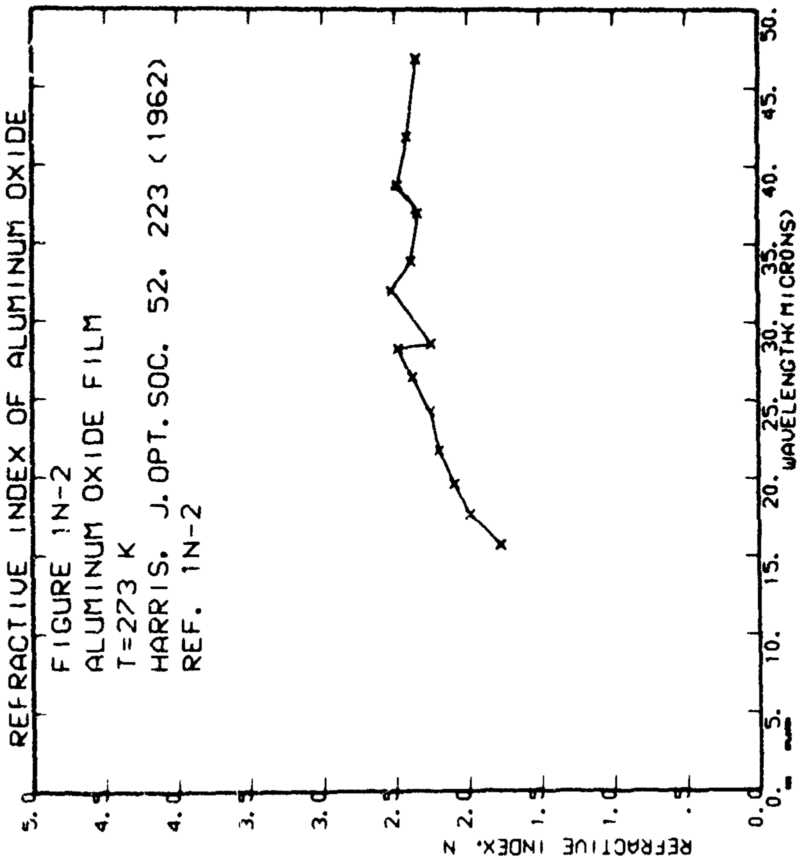
Harris and Piper (Ref. 1N-2)

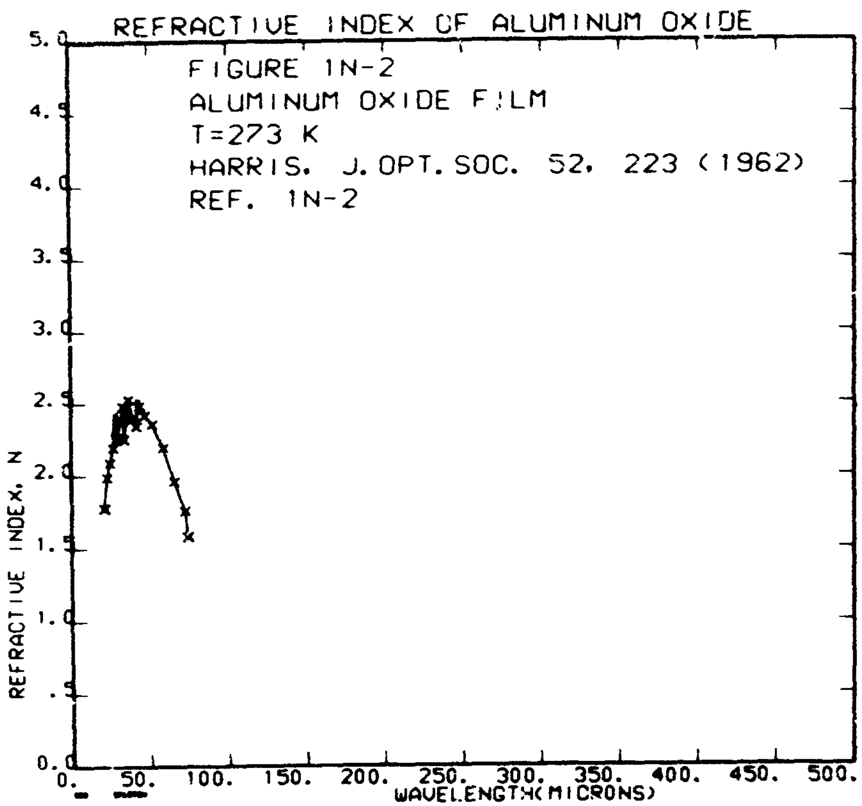
The refractive index of aluminum oxide films of 200 to 2800 Å thickness was determined using a grating spectrograph to measure transmittance and reflectance. No spectrometer bandpass or experimental error estimate was given. Data were digitized from a line.

No representative curve for films was constructed.

λ	n	λ	n	λ	n	λ	n
15.103	1.777E+00	17.085	1.985E+00	19.025	2.093E+00	21.103	2.197E+00
22.939	2.698E+00	23.615	2.262E+00	25.839	2.389E+00	27.661	2.482E+00
27.978	2.250E+00	31.438	2.527E+00	33.283	2.394E+00	36.362	2.344E+00
36.731	2.799E+00	38.150	2.482E+00	41.251	2.417E+00	46.278	2.355E+00
53.360	2.194E+00	60.392	1.955E+00	66.458	1.757E+00	68.867	1.579E+00


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-2
ALUMINUM OXIDE FILM
T=273 K
HARRIS. J.OPT.SOC. 52. 223 (1962)
REF. 1N-2
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-2
ALUMINUM OXIDE FILM
T=273 K
HARRIS. J.OPT.SOC. 52. 223 (1962)
REF. 1N-2
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)
0.
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-2
ALUMINUM OXIDE FILM
T=273 K
HARRIS. J. OPT. SOC. 52, 223 (1962)
REF. 1N-2
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0.0
REFRACTIVE INDEX, N
0.
50.
100.
150.
200.
250.
300.
350.
400.
450.
500.
WAVELENGTH(MICRONS)

Loewenstein (Ref. 1N-3)

Long wavelength refractive index measurements were made on sapphire at T = 1.5°K and 300°K using a far infrared Michaelson interferometer. The sapphire purity was not given, but no differences n_o or n_e were observed between the sapphire and ruby containing 0.9 percent Cr, 0.05 percent each Fe and Ti, and less than 0.001 percent of other impurities. No spectral bandpass information was given. Uncertainty in n is given as ± 0.002. Data were taken from tables.

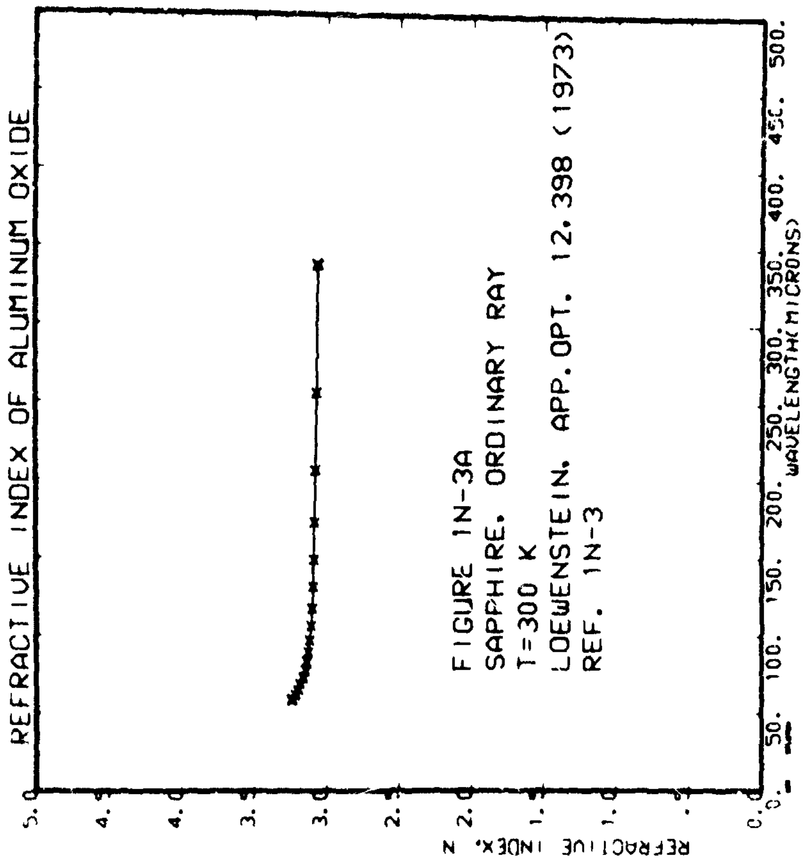
These tables were selected to construct the representative curve from 33μ to 55μ given in Section I, Figure I-1.1.

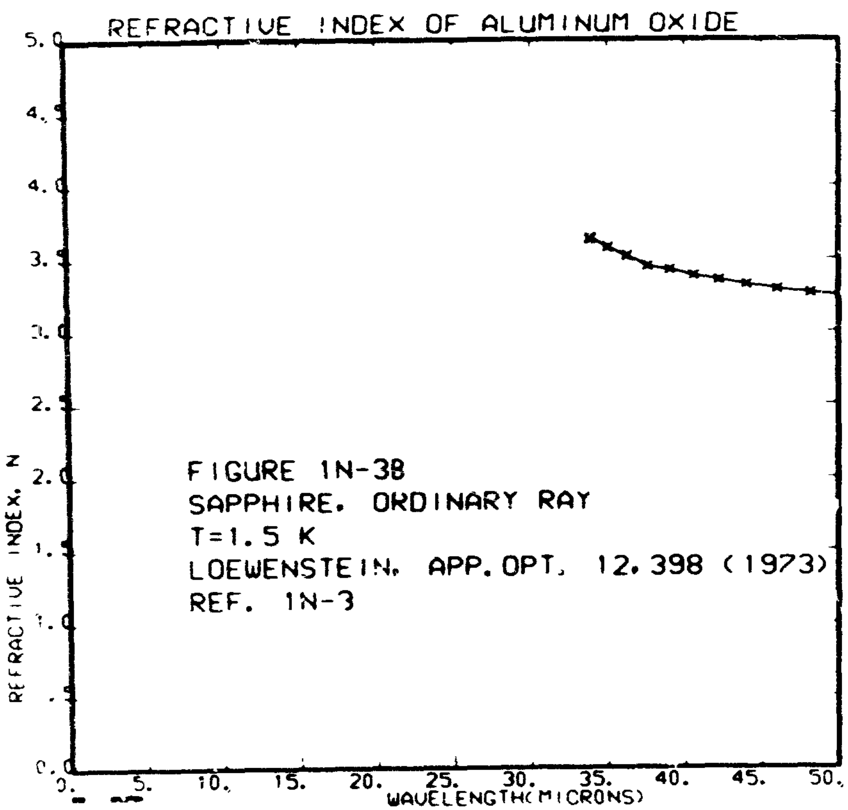
a. Ordinary Ray, T = 300°T

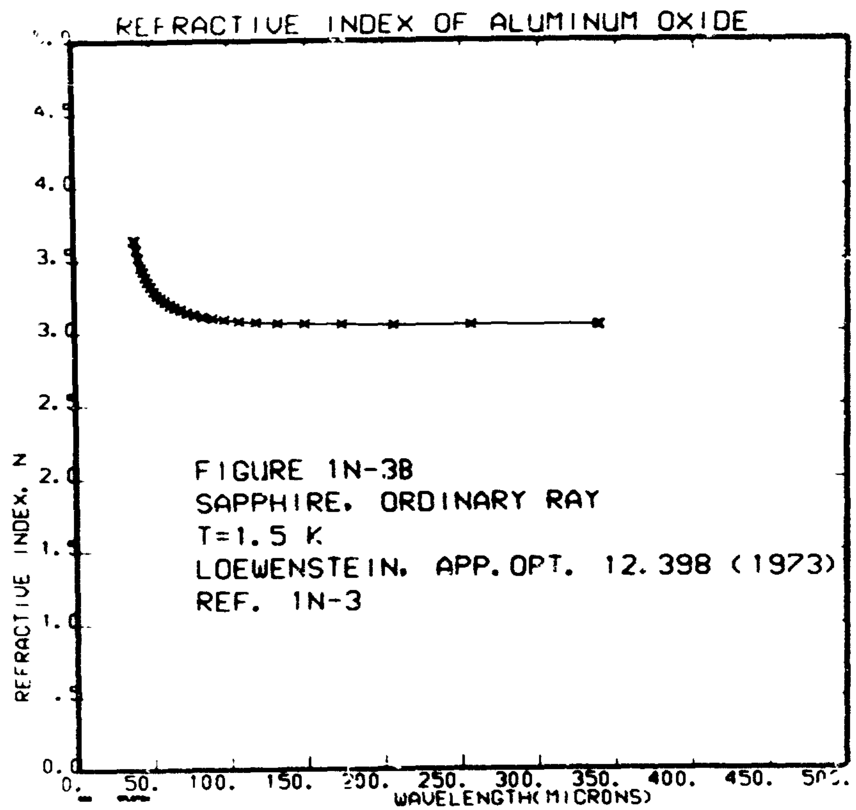
λ	n	λ	n	λ	n
333.333	3.069E+00	250.000	3.072E+00	200.000	3.076E+00
166.667	3.080E+00	142.857	3.085E+00	125.000	3.090E+00
111.111	3.097E+00	100.000	3.105E+00	90.909	3.114E+00
83.333	3.125E+00	76.923	3.136E+00	71.429	3.149E+00
66.667	3.164E+00	62.500	3.180E+00	58.824	3.198E+00
55.556	3.218E+00	52.632	3.241E+00		

b. Ordinary Ray, T = 1.5°K

λ	n	λ	n	λ	n
333.333	3.052E+00	250.000	3.055E+00	200.000	3.058E+00
166.667	3.062E+00	142.857	3.068E+00	125.000	3.073E+00
111.111	3.079E+00	100.000	3.087E+00	90.909	3.096E+00
83.333	3.106E+00	76.923	3.119E+00	71.429	3.132E+00
66.667	3.147E+00	62.500	3.167E+00	58.824	3.180E+00
55.556	3.198E+00	52.632	3.220E+00	50.000	3.240E+00
47.619	3.260E+00	45.455	3.287E+00	43.478	3.320E+00
41.667	3.350E+00	40.000	3.385E+00	38.462	3.428E+00
37.037	3.451E+00	35.714	3.522E+00	34.483	3.578E+00
33.333	3.636E+00				


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-3A
SAPPHIRE. ORDINARY RAY
T=300 K
LOEWENSTEIN. APP.OPT. 12.398 (1973)
REF. 1N-3
WAVELENGTH(MICRONS)
REFRACTIVE INDEX, N


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-38
SAPPHIRE. ORDINARY RAY
T=1.5 K
LOEWENSTEIN. APP.OPT. 12.398 (1973)
REF. 1N-3
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-38
SAPPHIRE. ORDINARY RAY
T=1.5 K
LOEWENSTEIN. APP.OPT. 12.398 (1973)
REF. 1N-3
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)

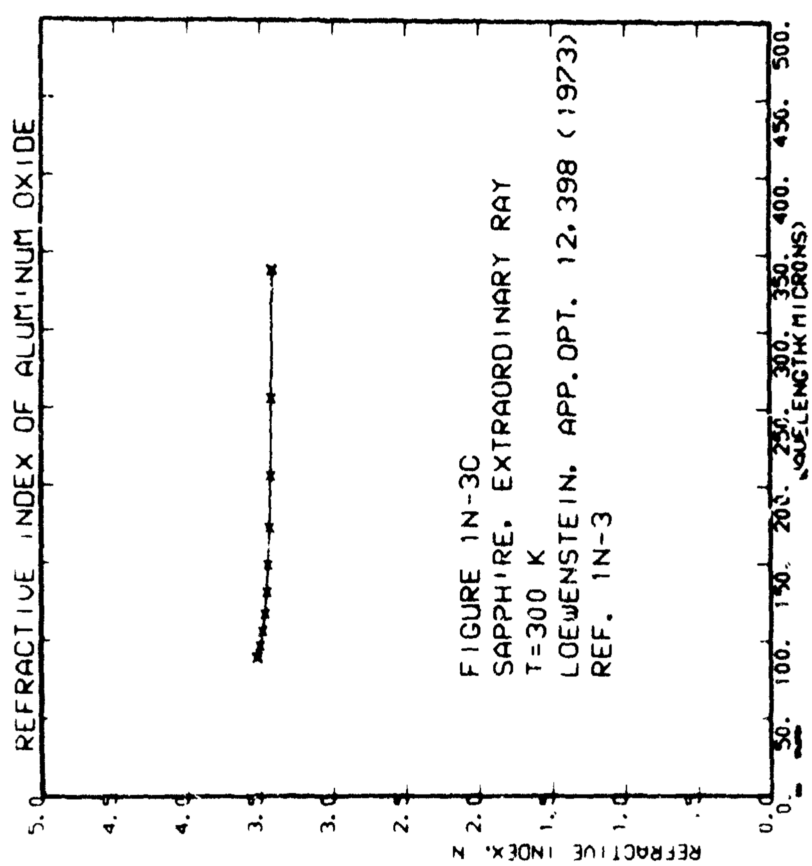
Loewenstein (Ref. 1N-3)

c. Extraordinary Ray, T = 300°K

λ	n	λ	n	λ	n
333.333	3.415E+00	250.000	3.420E+00	200.000	3.428E+00
166.667	3.436E+00	142.857	3.445E+00	125.000	3.455E+00
111.111	3.470E+00	100.000	3.485E+00	90.909	3.502E+00
83.333	3.524E+00				

d. Extraordinary Ray, T = 1.5°K

λ	n	λ	n	λ	n
333.333	3.372E+00	250.000	3.377E+00	200.000	3.382E+00
166.667	3.388E+00	142.857	3.396E+00	125.000	3.408E+00
111.111	3.416E+00	100.000	3.432E+00	90.909	3.451E+00
83.333	3.470E+00	76.923	3.498E+00	71.429	3.511E+00
66.667	3.535E+00	62.500	3.555E+00	58.824	3.595E+00
55.556	3.630E+00	52.632	3.667E+00	50.000	3.708E+00
47.619	3.755E+00	45.455	3.805E+00	43.478	3.858E+00
41.667	3.928E+00	40.000	3.993E+00	38.462	4.075E+00
37.037	4.160E+00	35.714	4.245E+00	34.483	4.315E+00


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE IN-3C
SAPPHIRE, EXTRAORDINARY RAY
T=300 K
LOEWENSTEIN, APP. OPT. 12, 398 (1973)
REF. IN-3
REFRACTIVE INDEX, N
WAVELENGTH (MICRONS)

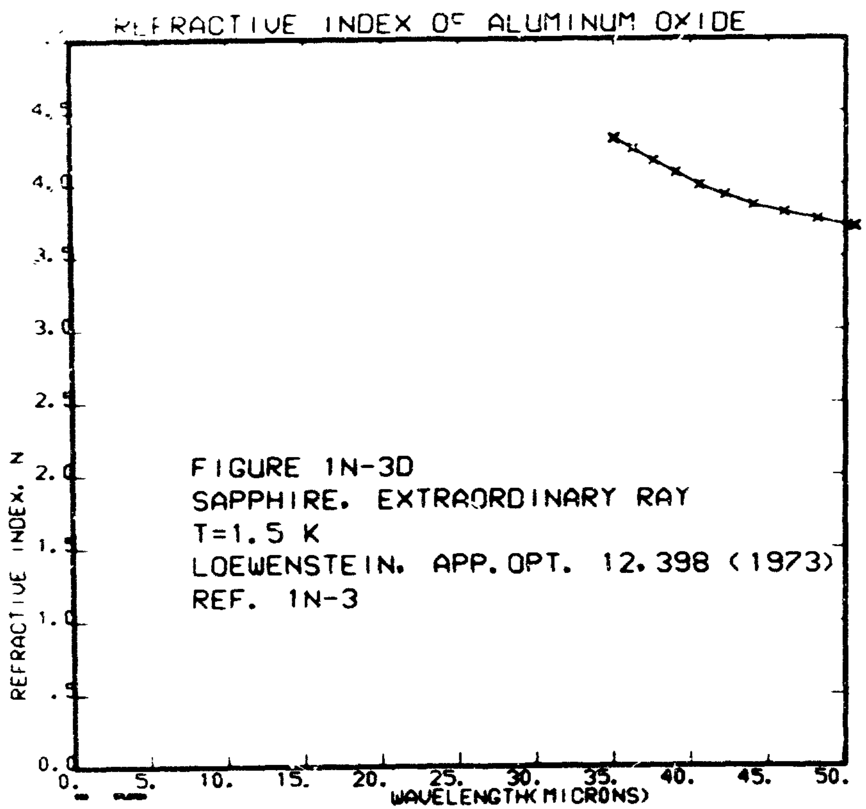


FIGURE 1N-3D
SAPPHIRE, EXTRAORDINARY RAY
T=1.5 K
LOEWENSTEIN, APP. OPT. 12, 398 (1973)
REF. 1N-3

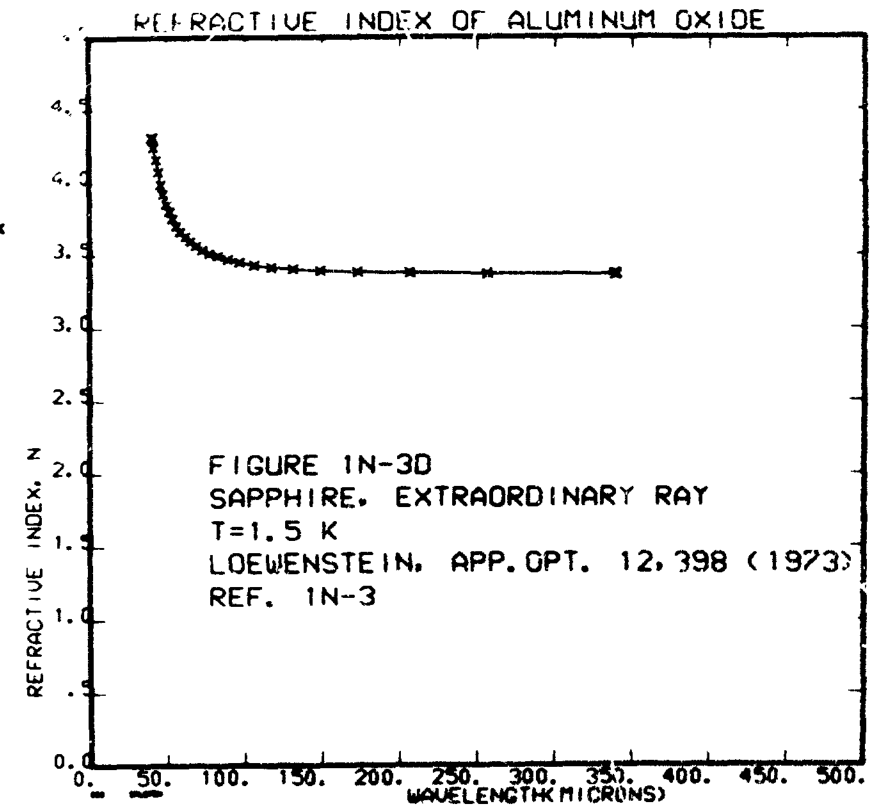


FIGURE 1N-3D
SAPPHIRE, EXTRAORDINARY RAY
T=1.5 K
LOEWENSTEIN, APP. OPT. 12, 398 (1973)
REF. 1N-3

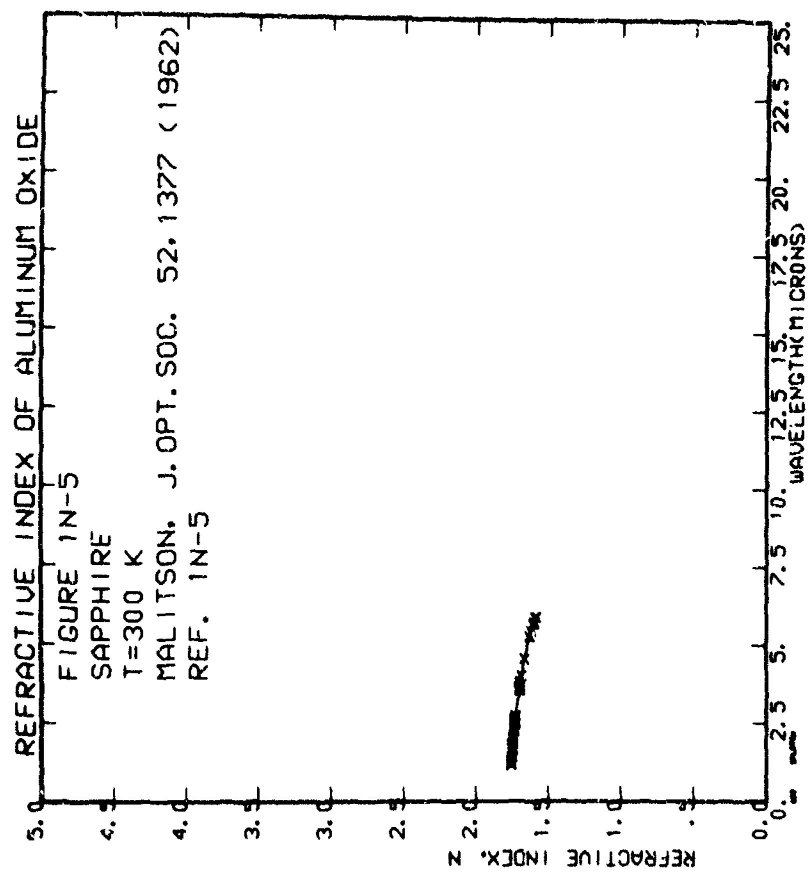
Malitson (Ref. 1N-5)

n_{ord} was measured at 297°K for a synthetic sapphire prism from Linde Co.; n is reported accurate to the fifth decimal place, and fits the n_{calc} equation below to an accuracy of $n_{obs} - n_{calc} \leq 8 \times 10^{-5}$ from 0.265μ to 5.58 μ. These data were taken from a table.

$$n^2_{calc} - 1 = \sum_i \frac{A_i \lambda^2}{\lambda^2 - \lambda_i^2} \quad \text{where} \quad \begin{aligned} \lambda_1 &= 0.06144821 \\ \lambda_2 &= 0.1106997 \\ \lambda_3 &= 17.92656 \\ A_1 &= 1.023798 \\ A_2 &= 1.058264 \\ A_3 &= 5.280792 \end{aligned}$$

These data were selected to construct the representative curve given in Section I, Figure I-1.1.

λ(μ)	n	λ	n	λ	n	λ	n
0.8944	1.75796	1.01398	1.75547	1.12866	1.75339	1.36728	1.74936
1.39506	1.74888	1.52952	1.74660	1.6932	1.74368	1.70913	1.74340
1.81307	1.74144	1.9701	1.73833	2.1526	1.73444	2.24929	1.73231
2.32542	1.73057	2.4374	1.72783	3.2439	1.70437	3.2668	1.70356
3.3026	1.70231	3.3303	1.70140	3.422	1.69818	3.5070	1.69504
3.7067	1.68746	4.2553	1.66371	4.954	1.62665	5.1456	1.61514
5.349	1.60202	5.419	1.59735	5.577	1.58638		


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE IN-5
SAPPHIRE
T=300 K
MALITSON. J.OPT.SOC. 52.1377 (1962)
REF. IN-5
WAVELENGTH(MICRONS)
REFRACTIVE INDEX, N
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0. 1. 2. 3. 4. 5.

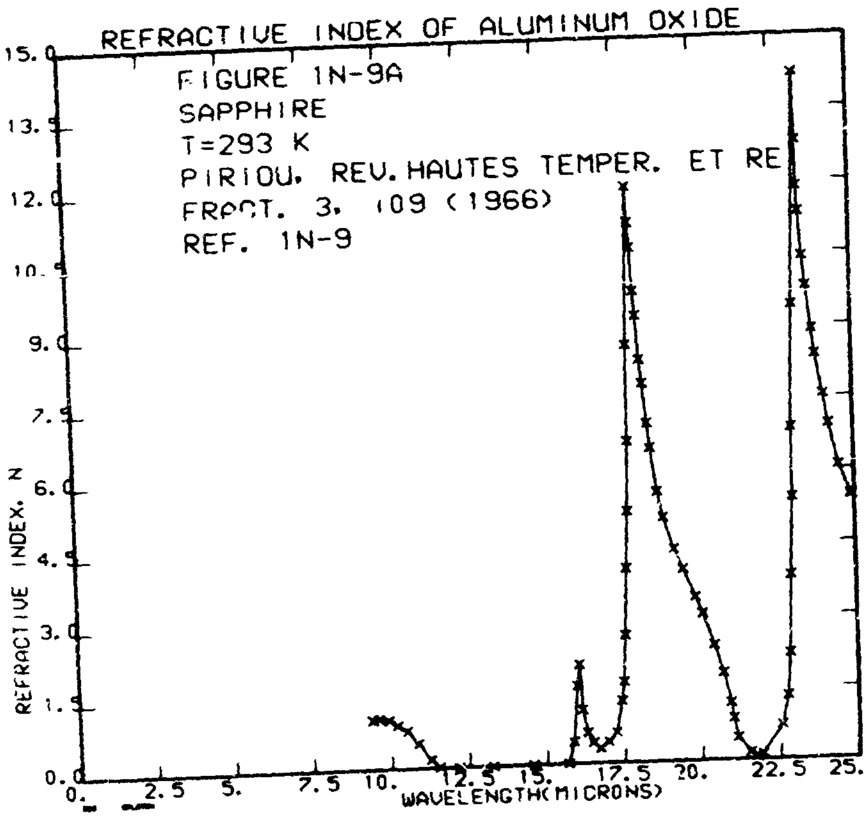
Piriou (Ref. 1N-9)

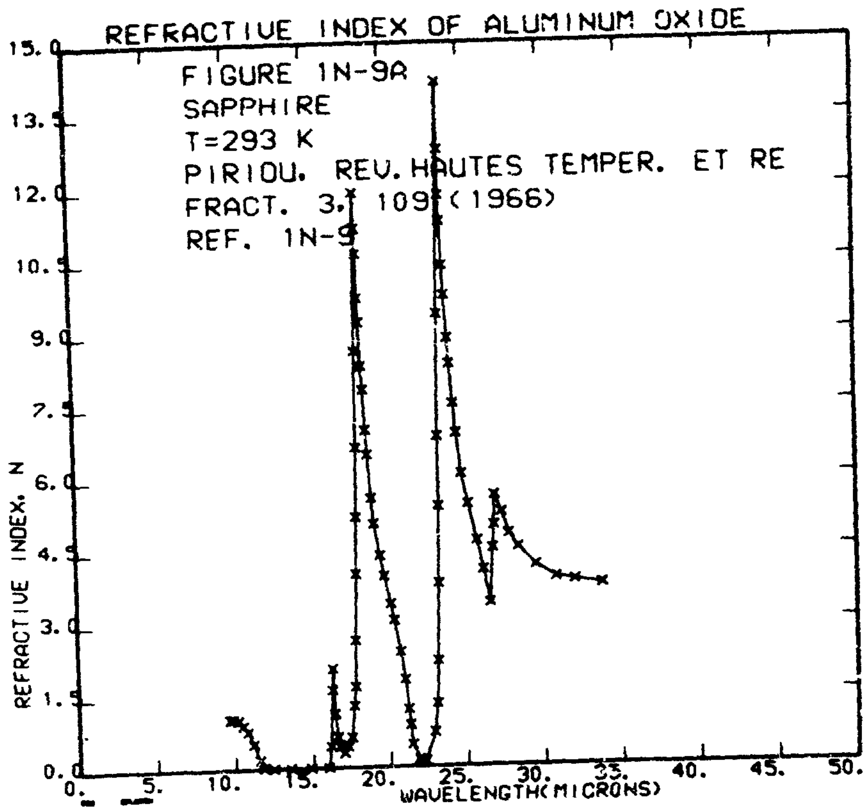
A grating spectrometer with an unspecified bandpass was used to measure the refractive index of sapphire (α - Al_2O_3) at T = 293°K and 1773°K. Temperatures were measured to ±1° using an optical pyrometer. No error analysis was given. Data were digitized from lines.

These data were selected to construct the representative curve given in Section I, Figure I-1.1.

a. T = 293°K

λ	n	λ	n	λ	n
33.190	3.761E+00	31.407	3.842E+00	30.204	3.905E+00
28.901	4.158E+00	27.805	4.530[illegible]+00	27.227	4.826E+00
26.730	5.274E+00	26.323	5.62[illegible] 00	26.276	5.007E+00
26.182	4.517E+00	25.969	3.373E+00	25.589	4.086E+00
25.193	4.681E+00	24.617	5.453E+00	24.227	6.077E+00
23.937	6.940E+00	23.779	7.545E+00	23.563	8.374E+00
23.466	8.919E+00	23.314	9.798E+00	23.216	1.042E+01
23.100	1.133E+01	23.049	1.187E+01	23.049	1.280E+01
23.017	1.421E+01	22.836	9.408E+00	22.731	6.870E+00
22.727	5.416E+00	22.647	3.813E+00	22.554	2.202E+00
22.472	1.315E+00	22.252	7.232E-01	21.647	1.183E-01
21.437	6.246E-02	21.246	1.611E-01	20.833	4.668E-01
20.717	8.777E-01	20.630	1.197E+00	20.422	1.828E+00
20.147	2.396E+00	19.782	3.044E+00	19.554	3.399E+00
19.174	3.988E+00	18.916	4.395E+00	18.581	5.066E+00
18.406	5.605E+00	18.221	6.510E+00	18.134	7.022E+00
18.012	7.862E+00	17.927	8.341E+00	17.840	9.263E+00
17.731	9.772E+00	17.702	1.068E+01	17.666	1.119E+01
17.621	1.195E+01	17.498	9.555E+00	17.480	6.672E+00
17.425	5.218E+00	17.359	4.020E+00	17.274	2.646E+00
17.211	1.686E+00	17.138	1.275E+00	16.9[illegible]1	6.377E-01
16.678	4.438E-01	16.329	3.024E-01	16.[illegible]	4.372E-01
16.007	6.476E-01	15.858	1.111E+00	15.[illegible]	[illegible]
15.719	1.631E+00	15.569	4.504E-01	15.395	6.[illegible]E-01
14.272	1.315E-02	12.964	1.315E-02	11.863	1.315E-02
11.223	1.644E-02	10.356	1.374E-01	10.552	5.293E-01
10.200	7.857E-01	9.906	9.106E-01	9.639	1.012E+00
9.317	1.039E+00	9.111	1.026E+00		

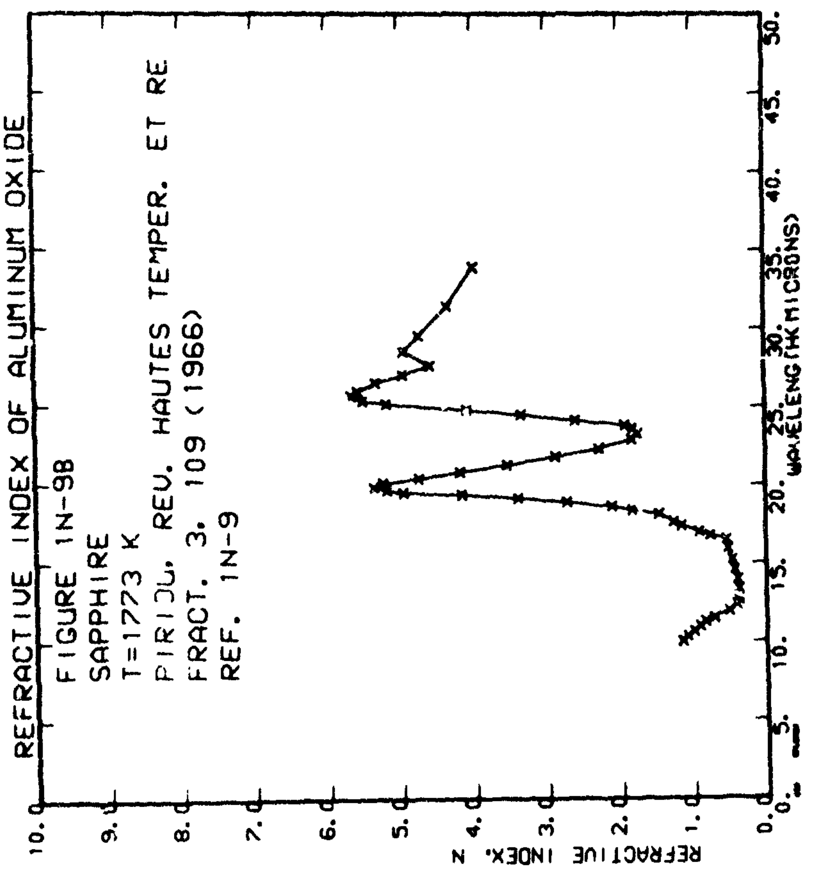

REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-9A
SAPPHIRE
T=293 K
PIRIOU. REV.HAUTES TEMPER. ET RE
FRACT. 3, 109 (1966)
REF. 1N-9
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)
15.0
13.5
12.0
9.0
7.5
6.0
4.5
3.0
1.5
0.0
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

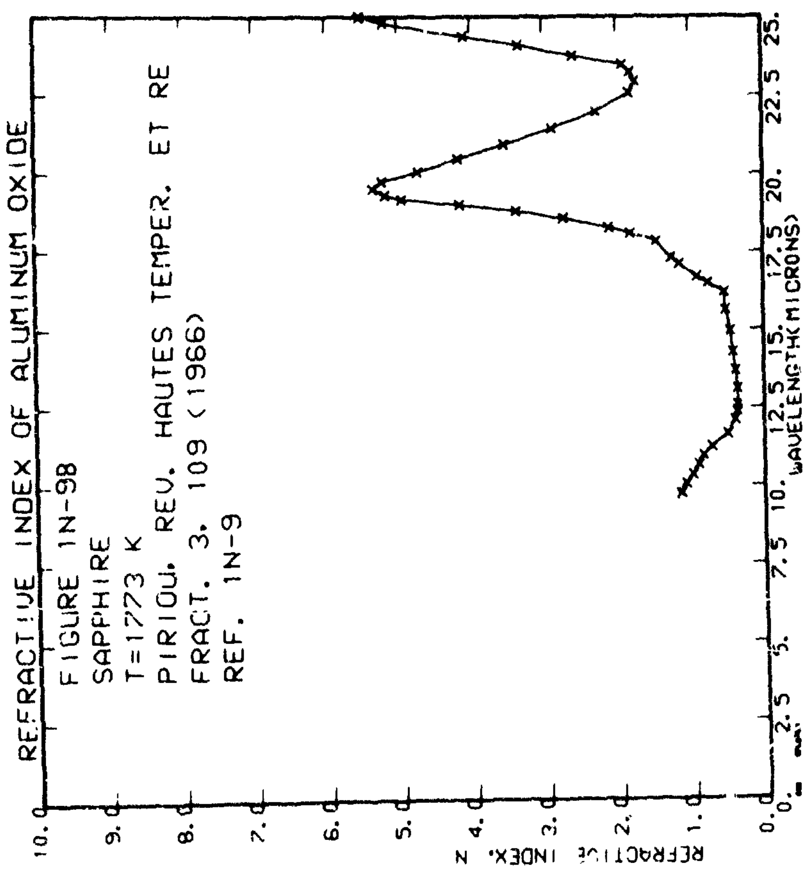

REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-9A
SAPPHIRE
T=293 K
PIRIOU. REV.HAUTES TEMPER. ET RE
FRACT. 3, 109 (1966)
REF. 1N-9
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)
15.0
13.5
12.0
10.5
9.0
7.5
6.0
4.5
3.0
1.5
0.0
0.
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.

Piriou (Ref. 1N-9)

b. T = 1773°K

λ	n	λ	n	λ	n
33.290	3.980E+00	30.751	4.341E+00	28.875	4.732E+00
27.859	4.958E+00	26.965	4.576E+00	26.393	4.951E+00
25.859	5.335E+00	25.312	5.582E+00	25.033	5.672E+00
24.719	5.525E+00	24.508	5.197E+00	24.097	4.095E+00
23.801	3.348E+00	23.472	2.608E+00	23.177	1.928E+00
22.949	1.817E+00	22.640	1.741E+00	22.275	1.831E+00
21.633	2.283E+00	21.170	2.881E+00	20.633	3.542E+00
20.195	4.180E+00	19.764	4.747E+00	19.460	5.233E+00
19.222	5.367E+00	19.021	5.139E+00	18.887	4.963E+00
18.796	4.166E+00	18.502	3.392E+00	18.257	2.738E+00
17.937	2.114E+00	17.789	1.833E+00	17.544	1.464E+00
17.016	1.267E+00	16.784	1.154E+00	16.373	9.126E-01
16.173	7.599E-01	15.876	5.453E-01	15.302	5.215E-01
14.629	4.642E-01	13.959	4.324E-01	13.361	3.927E-01
12.783	3.784E-01	12.266	3.736E-01	12.050	3.736E-01
11.730	4.038E-01	11.337	5.103E-01	10.929	7.202E-01
10.651	8.474E-01	10.359	9.173E-01	10.036	9.936E-01
9.724	1.087E+00	9.430	1.159E+00		


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-9B
SAPPHIRE
T=1773 K
PIRIOU, REV. HAUTES TEMPER. ET RE
FRACT. 3. 109 (1966)
REF. 1N-9
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)

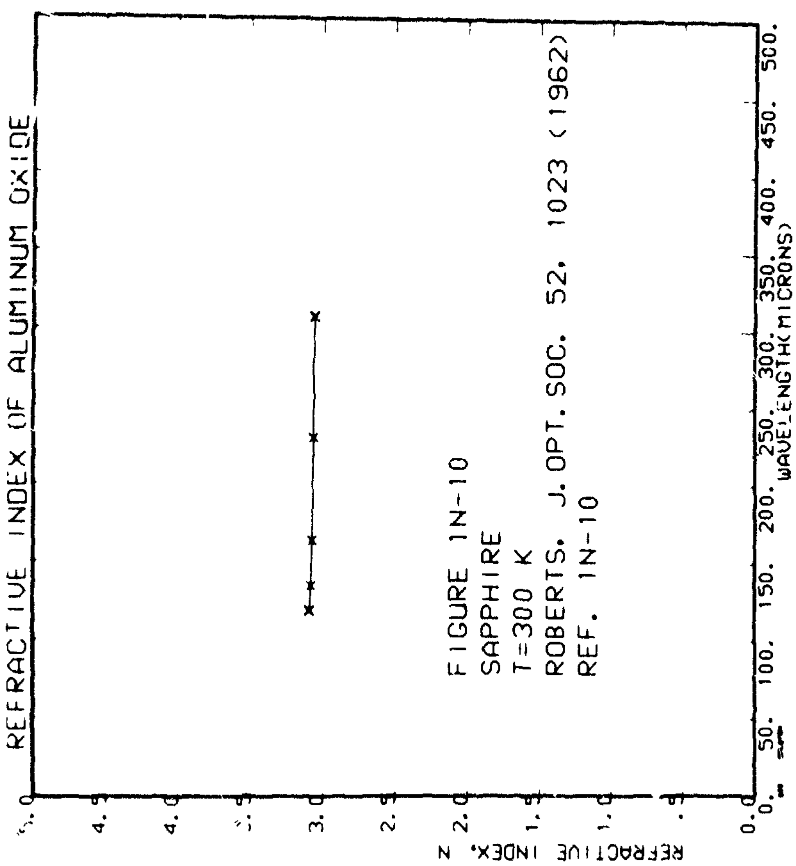

REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-9B
SAPPHIRE
T=1773 K
PIRIOU, REV. HAUTES TEMPER. ET RE
FRACT. 3. 109 (1966)
REF. 1N-9
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)

Roberts and Coon (Ref. IN-10)

n_o was measured for sapphire at $T \simeq 300^{\circ}K$ (unspecified room temperature) using a Czerny-Turner type grating monochromator with unspecified bandpass. The largest error was estimated to be ± 0.012, or ±0.1 percent. Data were digitized from a fitted straight line.

These data are in good agreement with the representative curve given in Section I.

λ	n	λ	n	λ	n	λ	n
113.000	3.092E+00	129.000	3.084E+00	158.000	3.076E+00	224.000	3.068E+00
302.000	3.054E+00						


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE IN-10
SAPPHIRE
T=300 K
ROBERTS. J. OPT. SOC. 52. 1023 (1962)
REF. IN-10
WAVELENGTH(MICRONS)
REFRACTIVE INDEX, N
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0.0 2.0 3.0 4.0

Russell (1N-11)

An asymmetric Fourier-transform method was used to measure n_o and n_e for sapphire. $T \cong 300^{o}K$ (unspecified room temperature). The total estimated probable error was $\pm$ 0.002 for 60 μ to 500 μ. These data were taken from a table.

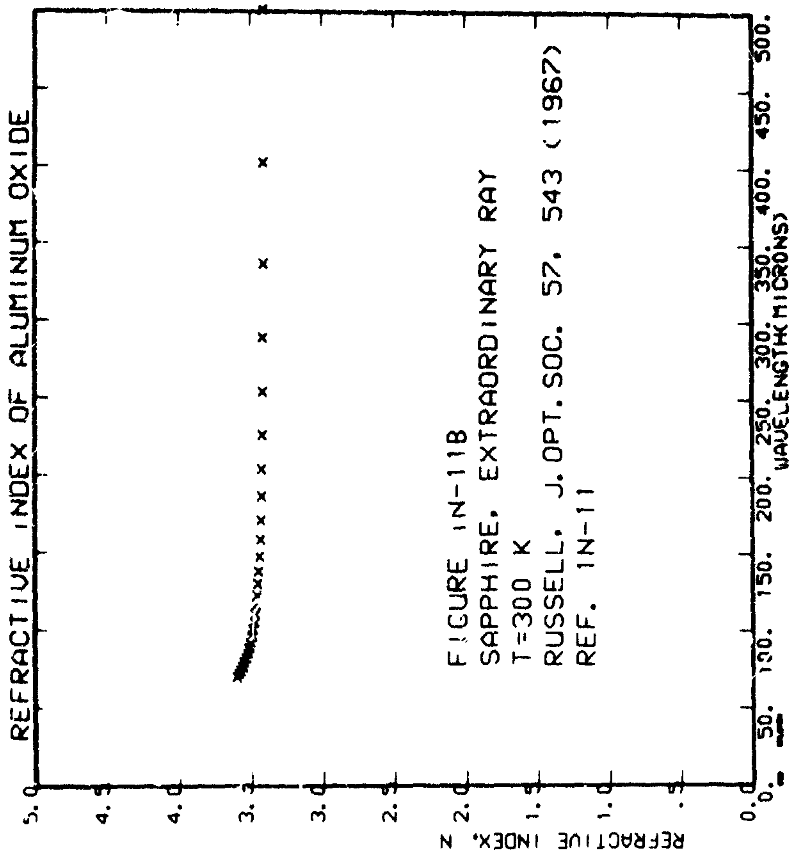
These data were selected to construct the representative curve given in Section I, Figure I-1.1.

a. n_o

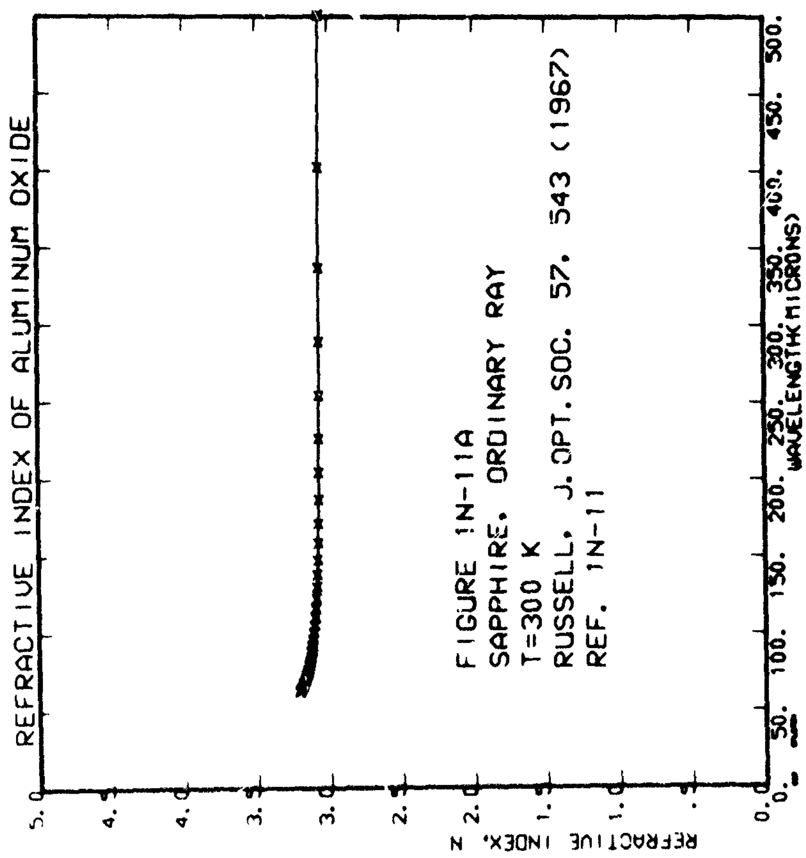
λ	n	λ	n	λ	n
4.950E+02	3.069E+00	3.968E+02	3.070E+00	3.311E+02	3.070E+00
2.833E+02	3.072E+00	2.481E+02	3.074E+00	2.203E+02	3.075E+00
1.984E+02	3.077E+00	1.805E+02	3.079E+00	1.653E+02	3.082E+00
1.527E+02	3.084E+00	1.416E+02	3.087E+00	1.323E+02	3.091E+00
1.241E+02	3.094E+00	1.167E+02	3.098E+00	1.103E+02	3.102E+00
1.044E+02	3.106E+00	9.921E+01	3.110E+00	9.452E+01	3.115E+00
9.017E+01	3.120E+00	8.628E+01	3.125E+00	8.271E+01	3.130E+00
7.937E+01	3.136E+00	7.634E+01	3.142E+00	7.348E+01	3.146E+00
7.087E+01	3.155E+00	6.845E+01	3.162E+00	6.614E+01	3.170E+00
6.432E+01	3.176E+00	6.200E+01	3.185E+00	6.013E+01	3.192E+00
5.338E+01	3.202E+00	5.669E+01	3.211E+00		

b. n_e

λ	n	λ	n	λ	n
4.950E+02	3.411E+00	2.833E+02	3.416E+00	1.984E+02	3.426E+00
1.527E+02	3.439E+00	1.241E+02	3.457E+00	1.044E+02	3.477E+00
9.017E+01	3.499E+00	7.937E+01	3.528E+00	7.087E+01	3.561E+00
6.402E+01	3.604E+00	3.968E+02	3.413E+00	2.481E+02	3.419E+00
1.805E+02	3.429E+00	1.416E+02	3.444E+00	1.167E+02	3.462E+00
9.921E+01	3.484E+00	8.628E+01	3.508E+00	7.634E+01	3.537E+00
6.845E+01	3.575E+00	3.311E+02	3.413E+00	2.203E+02	3.423E+00
1.653E+02	3.433E+00	1.323E+02	3.451E+00	1.103E+02	3.469E+00
9.452E+01	3.491E+00	8.271E+01	3.518E+00	7.348E+01	3.551E+00
6.514E+01	3.586E+00				



REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE IN-11B
SAPPHIRE, EXTRAORDINARY RAY
T=300 K
RUSSELL, J.OPT.SOC. 57, 543 (1967)
REF. IN-11
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)



REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE IN-11A
SAPPHIRE, ORDINARY RAY
T=300 K
RUSSELL, J.OPT.SOC. 57, 543 (1967)
REF. IN-11
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)

Streed (1N-12)

The refractive index of alumina particles of 1μ diameter and 99.95 percent purity and sapphire of 99.99 percent purity were measured using Kramers-Kronig analyses of polarized specular reflectance data obtained using a KBr prism spectrometer with a bandwidth of $0.016\,\mu$ to $0.15\,\mu$. No error analysis was given. The data were taken from tables.

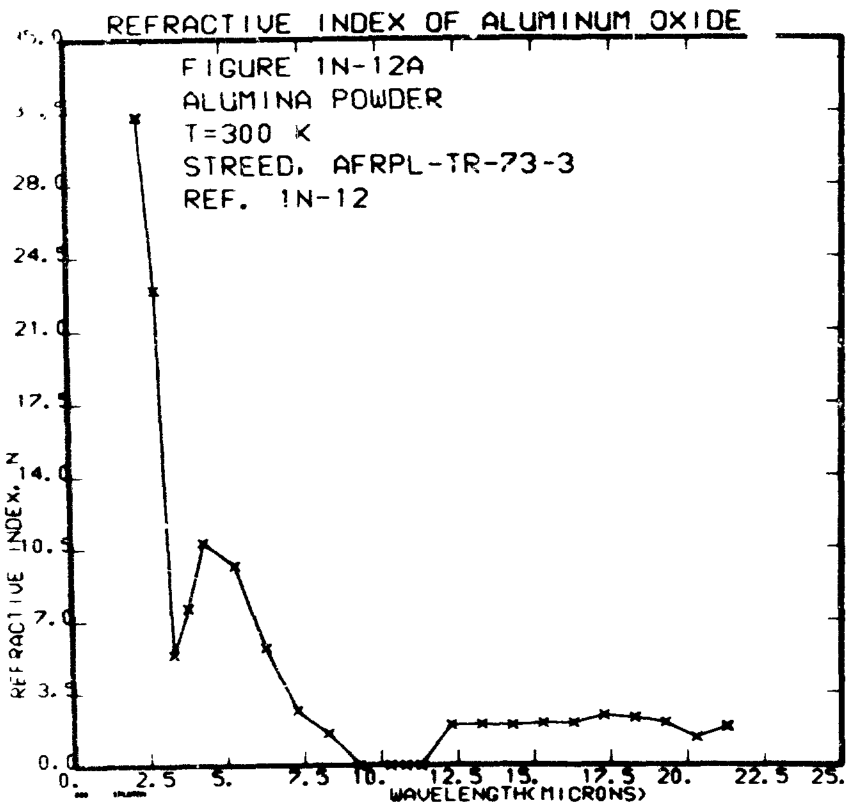
None of these data are in agreement with the representative curve given in Section I.

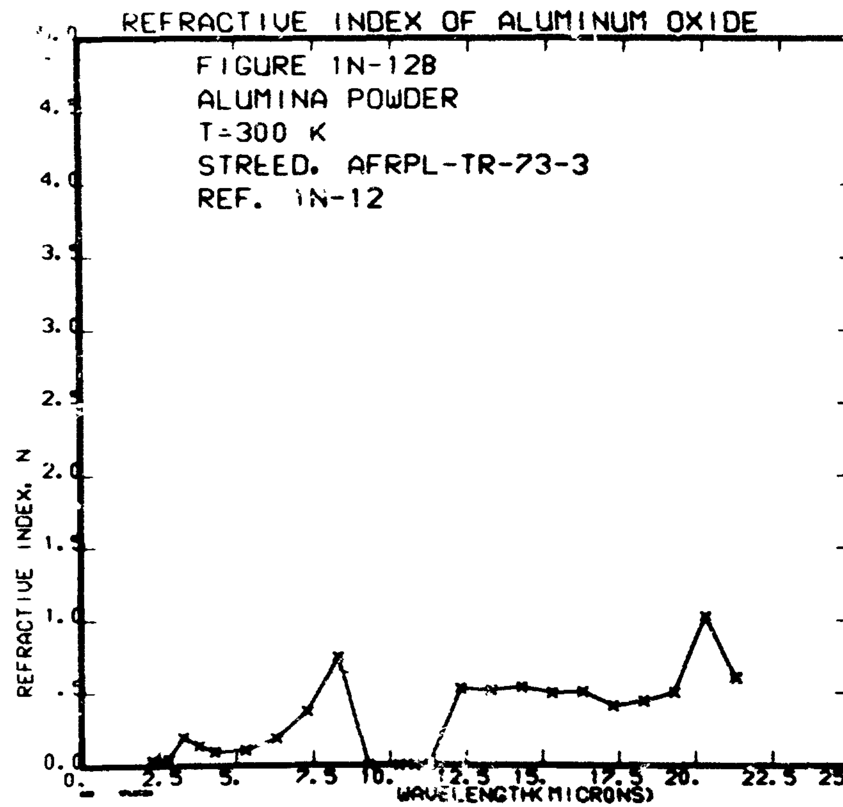
a. Alumina powder, first root of the Fresnel equation, T = 300°K.

λ	n	λ	n	λ	n	λ	n
2.000	31.300	2.500	22.960	3.000	5.360	3.500	7.620
4.000	10.810	5.000	9.660	6.000	5.670	7.000	2.590
8.000	1.560	9.000	0.000	10.000	0.000	10.500	0.000
11.000	0.000	12.000	1.970	13.000	2.610	14.000	1.980
15.000	2.080	16.000	2.080	17.000	2.440	18.000	2.310
19.000	2.370	20.000	1.340	21.000	1.870		

b. Alumina powder, second root of the Fresnel equation, T = 300°K.

λ	n	λ	n	λ	n	λ	n
2.000	.030	2.500	.040	3.000	.190	3.500	.130
4.000	.090	5.000	.100	6.000	.180	7.000	.370
8.000	.740	9.000	0.000	10.000	0.000	10.500	0.000
11.000	0.000	12.000	.520	13.000	.510	14.000	.530
15.000	.490	16.000	.530	17.000	.410	18.000	.440
19.000	.500	20.000	1.020	21.000	.600		


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-12A
ALUMINA POWDER
T=300 K
STREED, AFRPL-TR-73-3
REF. 1N-12
28.0
24.5
21.0
17.5
14.0
10.5
7.0
3.5
0.0
REFRACTIVE INDEX, N
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)


REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-12B
ALUMINA POWDER
T=300 K
STREED, AFRPL-TR-73-3
REF. 1N-12
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0.0
REFRACTIVE INDEX, N
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)

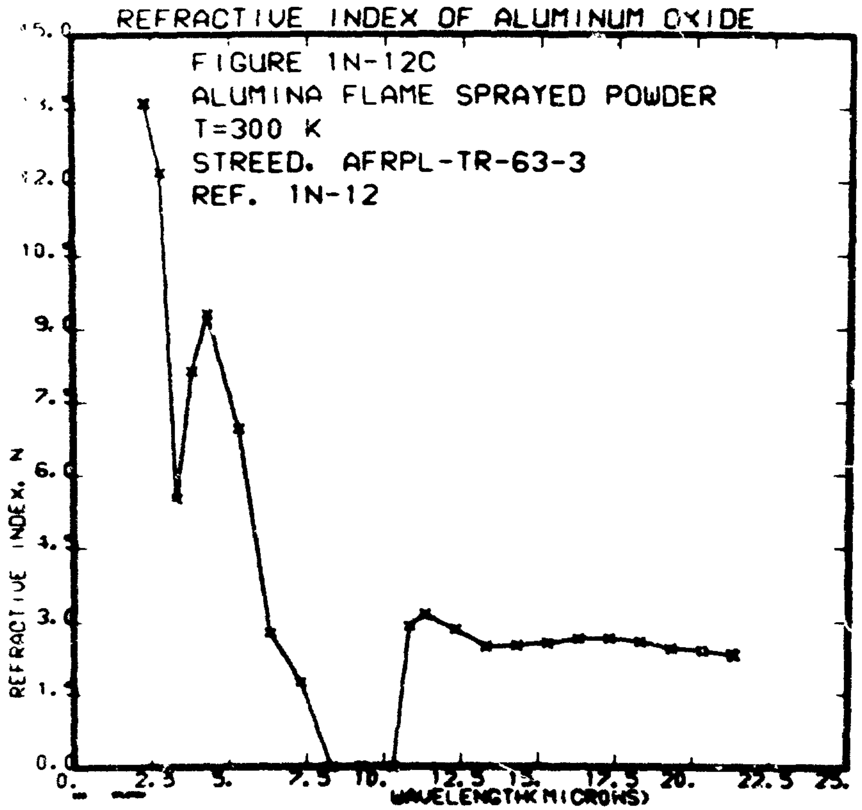
Streed (Ref. 1N-12)

c. Alumina flame sprayed powder, first root of the Fresnel equation, T = 300°K.

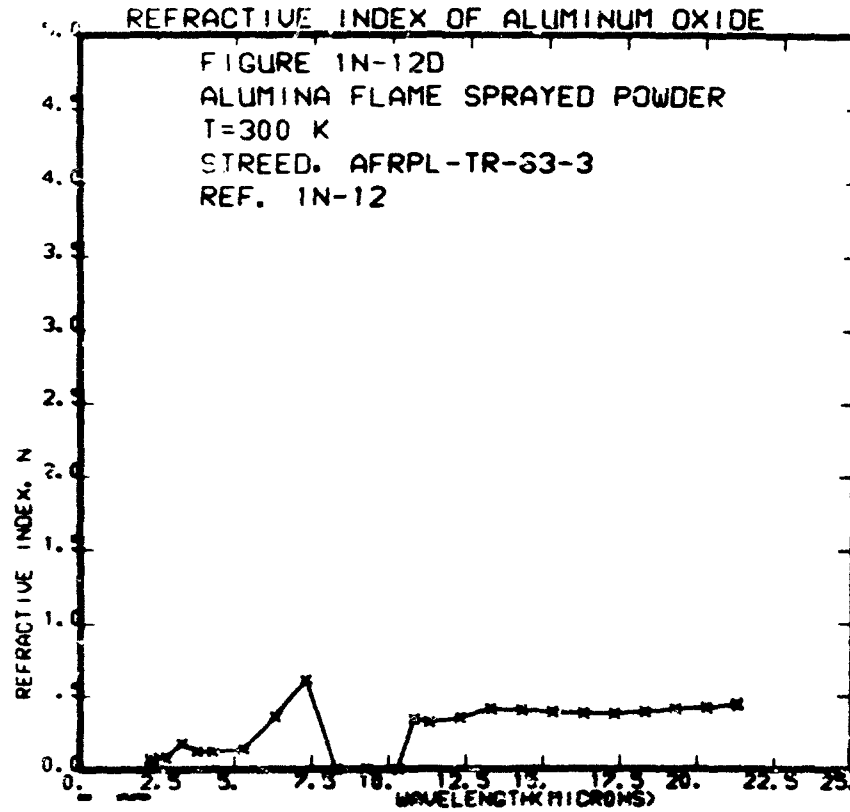
λ	n	λ	n	λ	n	λ	n
2.000	13.610	2.500	12.200	3.000	5.510	3.500	8.130
4.000	9.320	5.000	6.950	6.000	2.770	7.000	1.740
8.000	0.300	9.000	0.000	10.000	0.000	10.500	2.920
11.000	3.160	[illegible]	2.840	13.000	2.470	14.000	2.490
15.000	2.540	[illegible]	2.630	17.000	2.650	18.000	2.570
19.000	2.430	20.000	2.390	21.000	2.310		

d. Alumina flame sprayed powder, second root of the Fresnel equation, T = 300°K.

λ	n	λ	n	λ	n	λ	n
2.000	.070	2.500	.080	3.000	.180	3.500	.120
4.000	.120	5.000	.140	6.000	.360	7.000	.610
8.000	0.300	9.000	0.000	10.000	0.000	10.500	.340
11.000	.320	12.000	.350	13.000	.410	14.000	.400
15.000	.390	16.000	.380	17.000	.380	18.000	.390
19.000	.410	20.000	.420	21.000	.440		



REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-12C
ALUMINA FLAME SPRAYED POWDER
T=300 K
STREED. AFRPL-TR-63-3
REF. 1N-12
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)



REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-12D
ALUMINA FLAME SPRAYED POWDER
T=300 K
STREED. AFRPL-TR-63-3
REF. 1N-12
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)

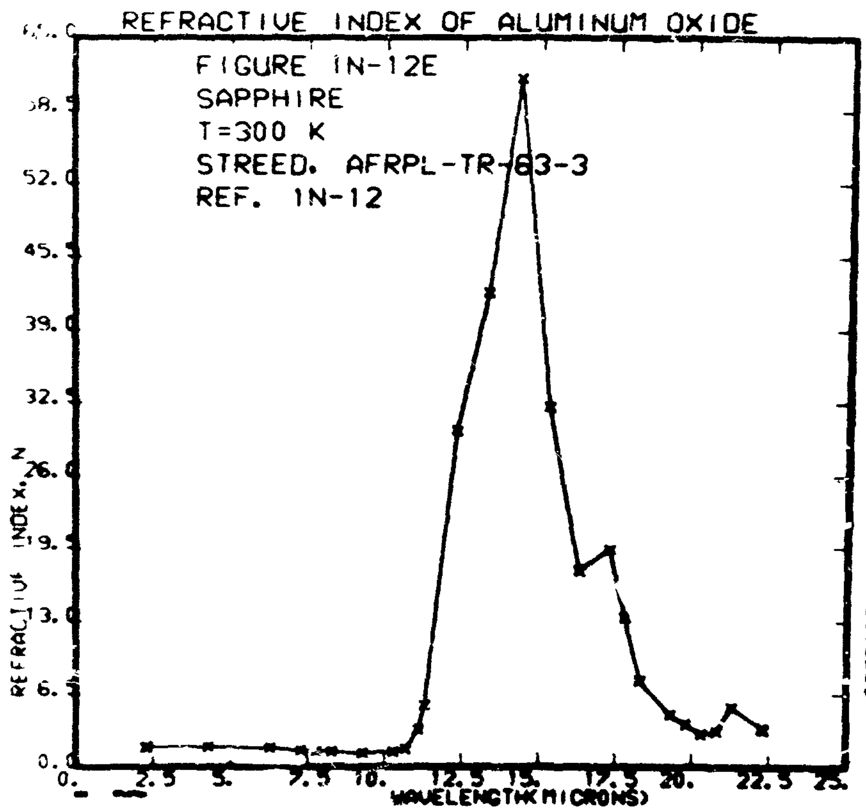
Streed (Ref. 1N-12)

e. Sapphire, first root of the Fresnel equation, T = 300°K

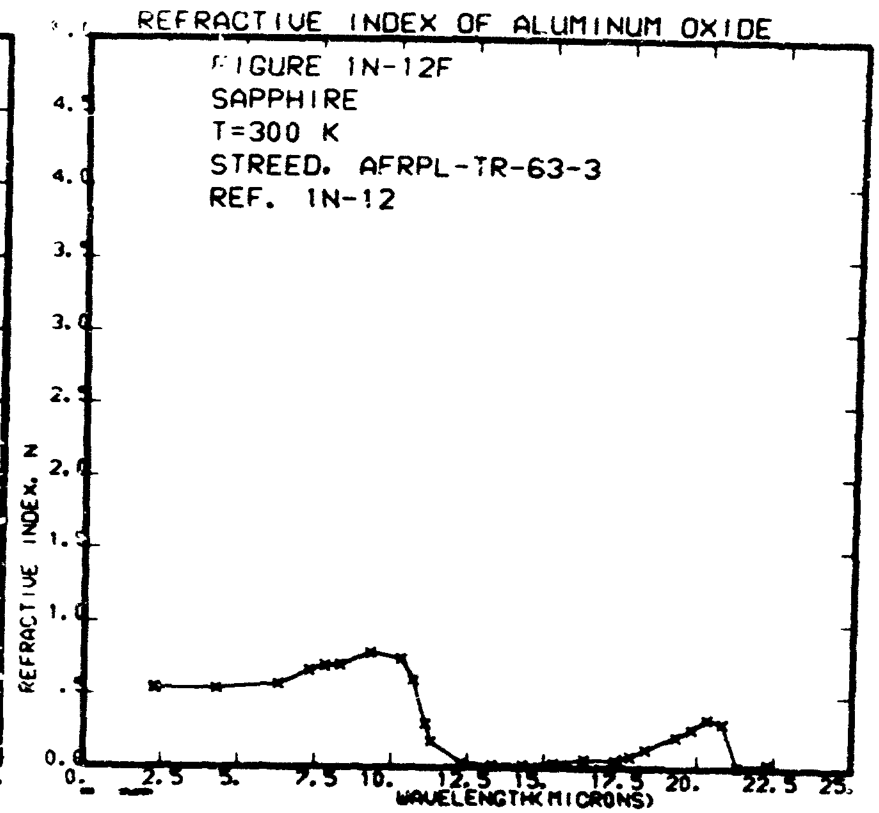
λ	n	λ	n	λ	n	λ	n
2.000	1.850	4.000	1.840	6.000	1.740	7.000	1.500
7.500	1.440	8.000	1.420	9.000	1.280	10.000	1.360
10.400	1.680	10.800	3.370	11.000	5.460	12.000	29.970
13.000	42.420	14.000	61.480	15.000	32.160	16.000	17.450
17.000	19.340	17.500	13.310	18.000	7.620	19.000	4.640
19.500	3.770	20.000	2.970	20.500	3.230	21.000	5.278
22.000	3.433						

f. Sapphire, second root of the Fresnel equation, T = 300°K.

λ	n	λ	n	λ	n	λ	n
2.000	5.400E-01	4.000	5.400E-01	6.000	5.700E-01	7.000	6.600E-01
7.500	6.300E-01	8.000	7.000E-01	9.000	7.800E-01	10.000	7.400E-01
10.400	6.000E-01	10.800	3.000E-01	11.000	1.800E-01	12.000	3.000E-02
13.000	2.000E-02	14.000	2.000E-02	15.000	3.000E-02	16.000	6.000E-02
17.000	5.000E-02	17.500	6.000E-02	18.000	1.300E-01	19.000	2.200E-01
19.500	2.700E-01	20.000	3.400E-01	20.500	3.100E-01	21.000	2.000E-02
22.000	3.000E-02						



REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE IN-12E
SAPPHIRE
T=300 K
STREED. AFRPL-TR-63-3
REF. IN-12
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)



REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE IN-12F
SAPPHIRE
T=300 K
STREED. AFRPL-TR-63-3
REF. IN-12
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)

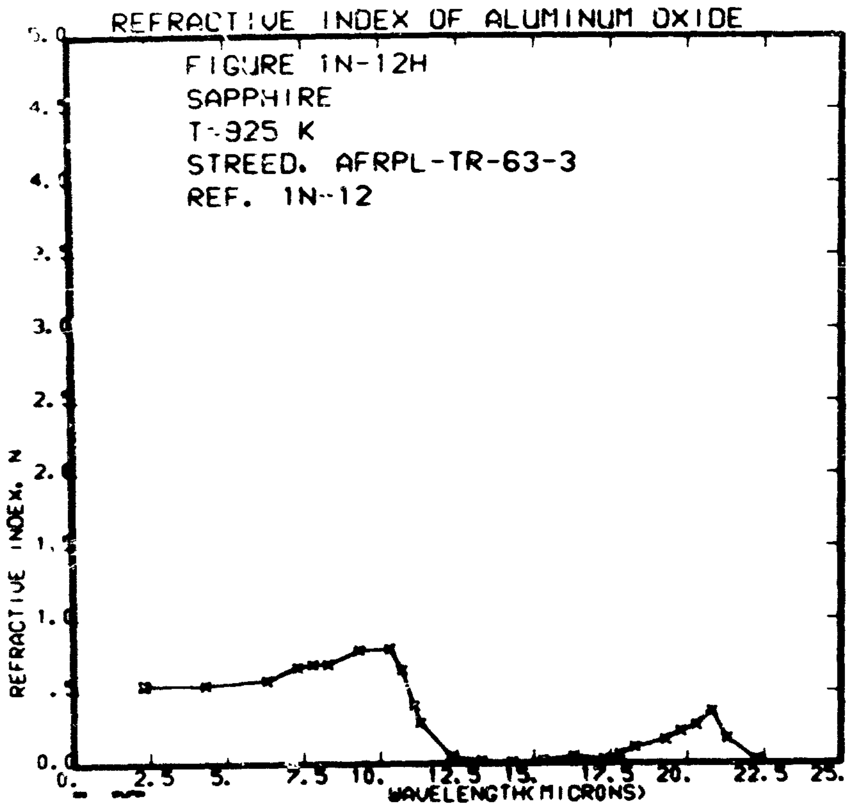
Streed (Ref. 1N-12)

g. Sapphire, first root of the Fresnel equation, $T = 925^{\circ}K$

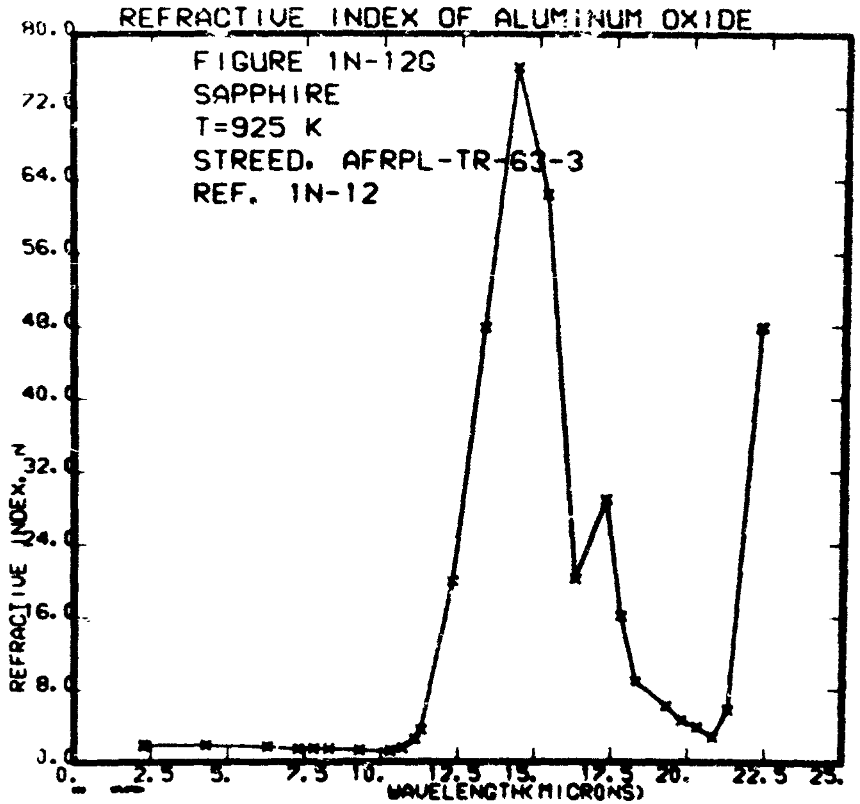
λ	n	λ	n	λ	n	λ	n
2.000	1.850	4.000	1.840	6.000	1.740	7.000	1.500
7.500	1.480	8.000	1.460	9.000	1.280	10.000	1.250
10.400	1.560	10.800	2.520	11.000	3.540	12.000	19.930
13.000	47.980	14.000	76.420	15.000	62.500	16.000	20.170
17.000	28.970	17.500	16.120	18.000	8.910	19.000	6.210
19.500	4.600	20.000	3.910	20.500	2.820	21.000	5.780
22.000	47.980						

h. Sapphire second root of the Fresnel equation, $T = 925^{\circ}K$

λ	n	λ	n	λ	n	λ	n
2.000	5.400E-01	4.000	5.400E-01	6.000	5.700E-01	7.000	6.600E-01
7.500	6.800E-01	8.000	6.800E-01	9.000	7.800E-01	10.000	7.900E-01
10.400	6.400E-01	10.800	4.000E-01	11.000	2.800E-01	12.000	5.000E-02
13.000	2.000E-02	14.000	1.000E-02	15.000	2.000E-02	16.000	5.000E-02
17.000	3.000E-02	17.500	6.000E-02	18.000	1.100E-01	19.000	1.600E-01
19.500	2.200E-01	20.000	2.600E-01	20.500	3.600E-01	21.000	1.700E-01
22.000	2.000E-02						



REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-12H
SAPPHIRE
T-925 K
STREED. AFRPL-TR-63-3
REF. 1N-12
REFRACTIVE INDEX, N
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.



REFRACTIVE INDEX OF ALUMINUM OXIDE
FIGURE 1N-12G
SAPPHIRE
T=925 K
STREED. AFRPL-TR-63-3
REF. 1N-12
REFRACTIVE INDEX, N
80.0
72.0
64.0
56.0
48.0
40.0
32.0
24.0
16.0
8.0
0.0
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

III-1 2 Tabulated Extinction Coefficient Data - Aluminum Oxide

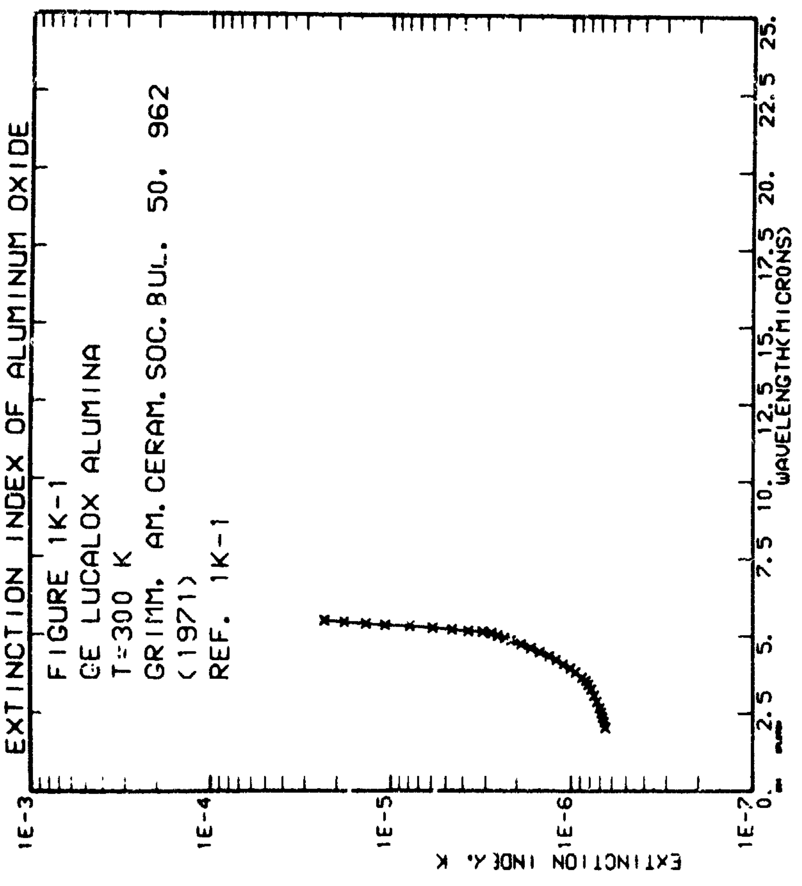
Contents:

Grimm (Ref. 1K-1)

The in-line loss coefficient of General Electric Lucalox high density polycrystalline alumina with 0.2 percent MgO content, a density of 3.975 g/cm^3, and grain size of 27 $\pm$ 3μ was measured on a Perkin-Elmer 337 double beam spectrophotometer with an undisclosed bandpass. No error analysis or temperature was given. Data were digitized from a curve.

These data were selected to construct the representative curve presented in Section I, Figure I - 1.2.

λ	k	λ	k	λ	k
2.062	6.530E-07	2.244	6.661E-07	2.381	6.783E-07
2.540	6.904E-07	2.694	7.031E-07	2.885	7.268E-07
3.092	7.524E-07	3.280	7.810E-07	3.444	8.095E-07
3.554	8.360E-07	3.658	8.727E-07	3.830	9.471E-07
3.948	1.014E-06	4.089	1.110E-06	4.230	1.218E-06
4.350	1.337E-06	4.491	1.502E-06	4.613	1.682E-06
4.741	1.895E-06	4.853	2.148E-06	4.929	2.336E-06
5.015	2.559E-06	5.081	2.795E-06	5.133	3.102E-06
5.171	3.709E-06	5.212	4.583E-06	5.256	5.859E-06
5.299	7.850E-06	5.346	1.084E-05	5.384	1.374E-05
5.434	1.813E-05	5.478	2.338E-05		


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-1
GE LUCALOX ALUMINA
T=300 K
GRIMM. AM. CERAM. SOC. BUL. 50. 962
(1971)
REF. 1K-1
EXTINCTION INDEX, K
1E-3
1E-4
1E-5
1E-6
1E-7
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

Gryvnak (Ref. 1K-2)

The absorption coefficient of sapphire from 1 to 6 μ and T = 296 to 2293°K using a Perkin Elmer 112 spectrometer with an NaCl prism with an unspecified bandpass. For values of $k < 0.001 \text{ mm}^{-1}$ the estimated error may be as high as 30 percent. For $k > 0.001 \text{ mm}^{-1}$, the estimated error is less than 15 percent. These data were digitized from continuous curves.

These data are in good agreement with the representative curve given in Section I-1.2.

a. T = 296°K

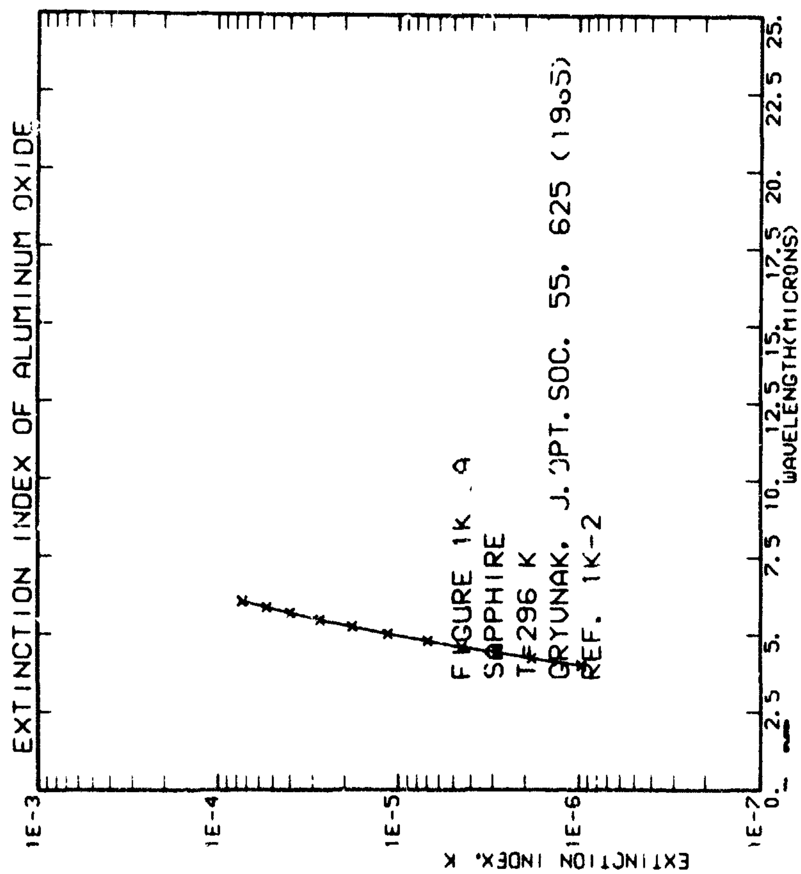
λ	k	λ	k	λ	k	λ	k
4.317	9.683E-07	4.235	1.820E-06	4.405	2.804E-06	4.586	4.463E-06
4.774	5.850E-06	5.008	1.140E-05	5.246	1.809E-05	5.469	2.713E-05
5.690	3.966E-05	5.866	5.349E-05	6.059	7.354E-05		

b. T = 673°K

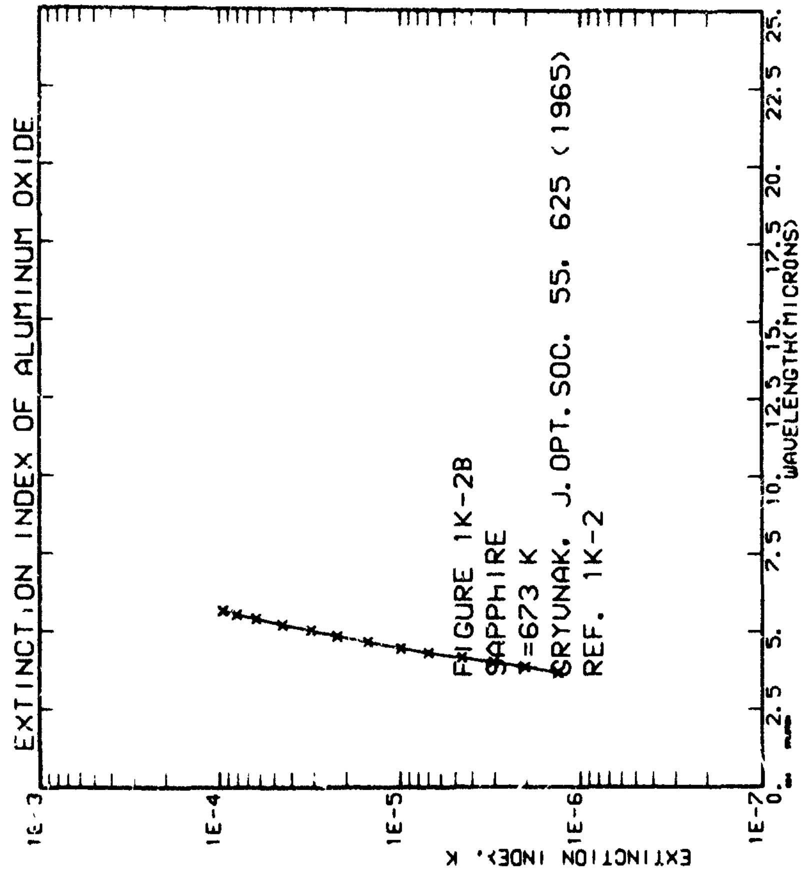
λ	k	λ	k	λ	k	λ	k
3.597	1.332E-06	3.849	2.321E-06	4.061	3.035E-06	4.155	4.534E-06
4.314	6.930E-06	4.462	9.982E-06	4.653	1.507E-05	4.845	2.227E-05
5.024	3.113E-05	5.216	4.451E-05	5.402	6.262E-05	5.545	8.021E-05
5.556	9.518E-05						

c. T = 1073°K

λ	k	λ	k	λ	k	λ	k
3.923	1.115E-06	4.101	1.379E-06	4.271	2.948E-06	4.451	4.594E-06
4.626	5.383E-06	4.837	1.105E-05	5.034	1.662E-05	5.226	2.383E-05
5.397	3.292E-05	5.559	4.355E-05	5.743	6.123E-05		



EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K
SAPPHIRE
T=296 K
GRYUNAK, J. OPT. SOC. 55, 625 (1965)
REF. 1K-2
EXTINCTION INDEX, K
WAVELENGTH(MICRONS)
1E-3
1E-4
1E-5
1E-6
1E-7
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.



EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-2B
SAPPHIRE
T=673 K
GRYUNAK, J. OPT. SOC. 55, 625 (1965)
REF. 1K-2
EXTINCTION INDEX, K
WAVELENGTH(MICRONS)
1E-3
1E-4
1E-5
1E-6
1E-7
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

Gryvnak (Ref. 1K-2)

d. T = 1473°K

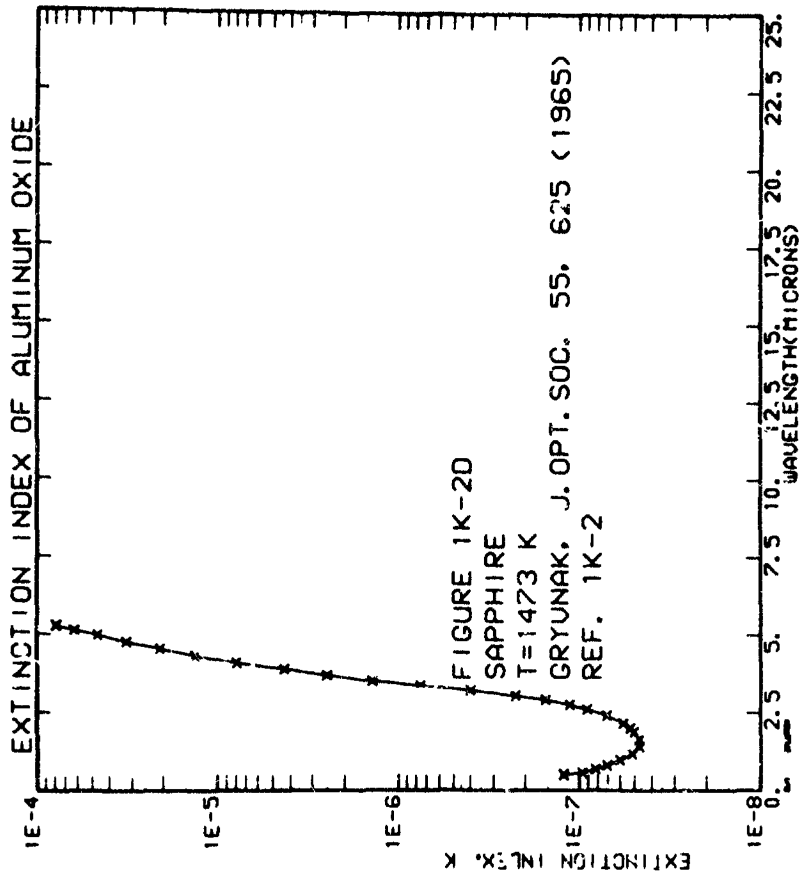
λ	k	λ	k	λ	k	λ	k
.511	1.232E-07	.578	3.633E-08	.681	8.171E-08	.815	7.048E-08
.977	5.300E-08	1.175	5.133E-08	1.412	4.650E-08	1.546	4.677E-08
1.363	4.977E-08	2.005	3.224E-08	2.161	5.749E-08	2.403	7.079E-08
2.621	9.989E-08	2.[illegible]67	1.133E-07	2.914	1.551E-07	3.047	2.257E-07
3.20[illegible]	4.004E-07	3.346	7.554E-07	3.518	1.399E-06	3.697	2.510E-06
3.851	4.337E-06	4.[illegible]96	7.927E-06	4.309	1.321E-05	4.535	2.083E-05
4.7[illegible]0	3.210E-05	[illegible]	4.518E-05	5.146	6.225E-05	5.282	7.817E-05

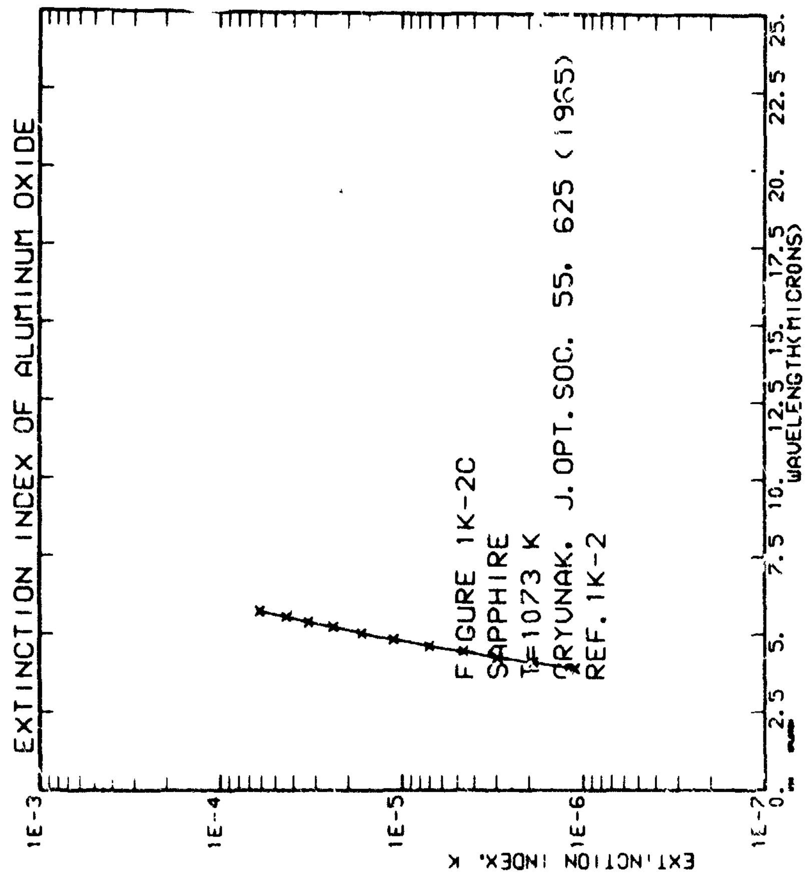
e. T = 1773°K

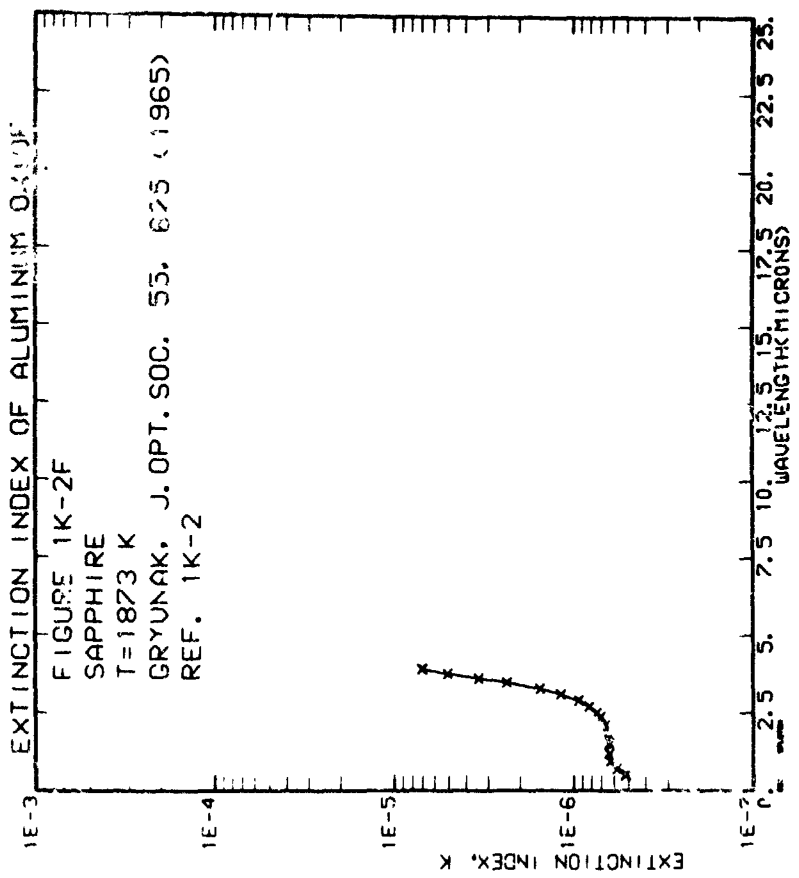
λ	k	λ	k	λ	k	λ	k
.463	2.521E-07	.621	2.763E-07	.822	2.861E-07	1.042	2.877E-07
1.252	2.862E-07	1.560	2.872E-07	1.775	2.935E-07	2.073	3.110E-07
2.253	3.322E-07	2.348	3.444E-07	2.504	3.762E-07	2.735	4.558E-07
2.936	3.590E-07	3.123	7.433E-07	3.280	1.067E-06	3.43[illegible]	1.626E-06
3.603	2.509E-06	3.783	4.251E-06	3.959	7.021E-06	4.17[illegible]	1.212E-05
4.374	1.988E-05	4.594	3.039E-05	4.789	4.419E-05	4.956	6.104E-05
5.113	8.157E-05						

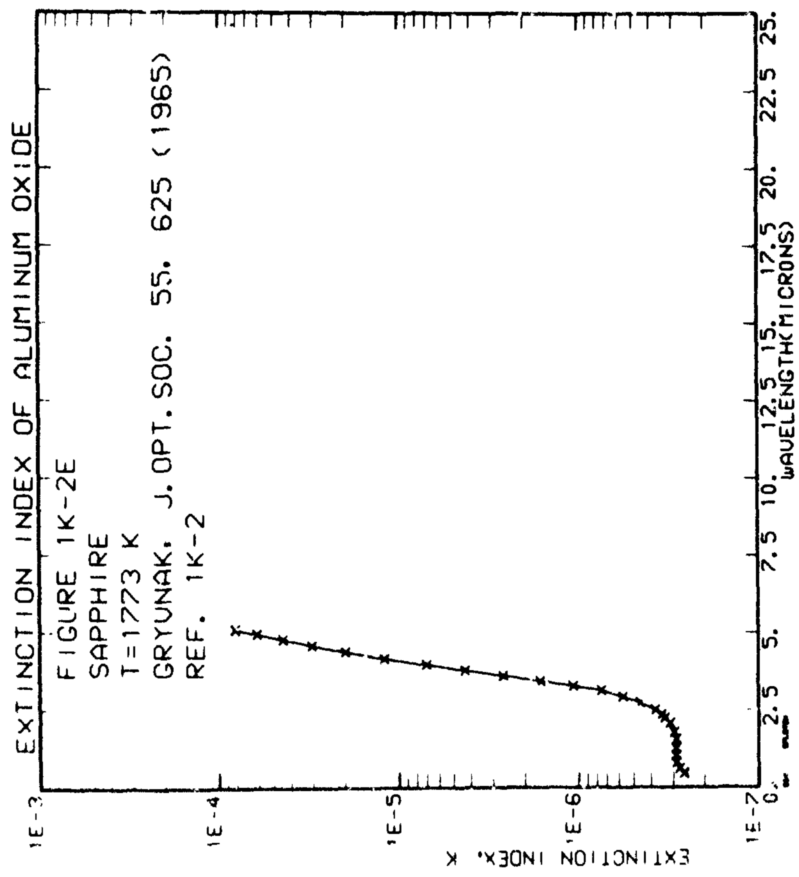
f. T = 1873°K

λ	k	λ	k	λ	k	λ	k
.506	5.173E-07	.702	5.765E-07	.952	6.220E-07	1.212	6.313E-07
1.529	5.322E-07	1.872	6.441E-07	2.123	6.636E-07	2.397	7.100E-07
2.505	7.397E-07	2.700	8.167E-07	2.900	9.385E-07	3.117	1.185E-06
3.291	1.539E-06	3.492	2.353E-06	3.615	3.396E-06	3.761	5.314E-06
3.699	7.015E-05						


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-2D
SAPPHIRE
T=1473 K
GRYUNAK. J.OPT.SOC. 55. 625 (1965)
REF. 1K-2
EXTINCTION INDEX, K
1E-4
1E-5
1E-6
1E-7
1E-8
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-2C
SAPPHIRE
T=1073 K
GRYUNAK. J.OPT.SOC. 55. 625 (1965)
REF. 1K-2
EXTINCTION INDEX, K
1E-3
1E-4
1E-5
1E-6
1E-7
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.


EXTINCTION INDEX OF ALUMINUM O
FIGURE 1K-2F
SAPPHIRE
T=1873 K
GRYUNAK. J.OPT.SOC. 55. 625 (1965)
REF. 1K-2
EXTINCTION INDEX, K
1E-3
1E-4
1E-5
1E-6
1E-7
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-2E
SAPPHIRE
T=1773 K
GRYUNAK. J.OPT.SOC. 55. 625 (1965)
REF. 1K-2
EXTINCTION INDEX, K
1E-3
1E-4
1E-5
1E-6
1E-7
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)

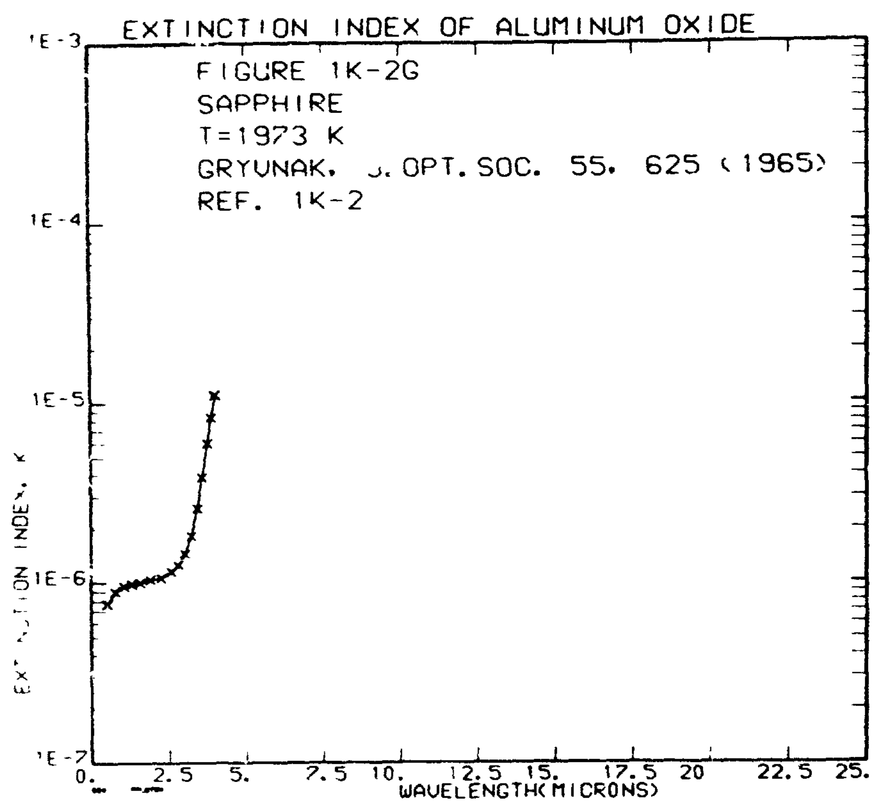
Gryvnak (Ref. 1K-2)

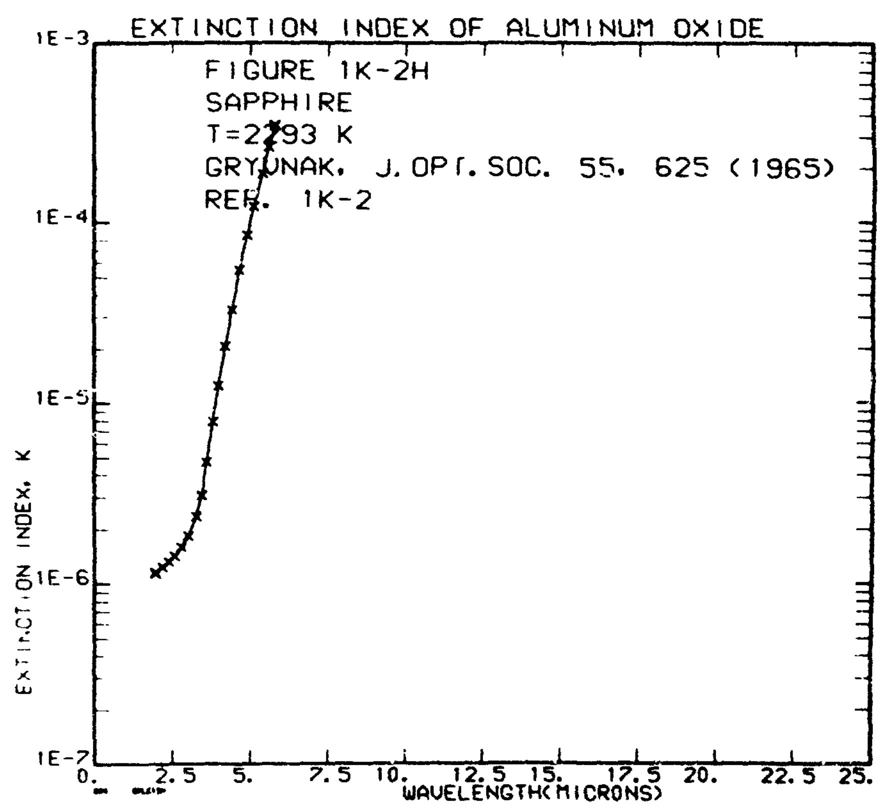
g. T = 1973^{o}K

λ	k	λ	k	λ	k	λ	k
.538	7.706E-07	.786	8.974E-07	1.085	9.596E-07	1.336	9.846E-07
1.621	1.005E-06	1.947	1.042E-06	2.280	1.064E-06	2.605	1.15[illegible]E-06
2.827	1.248E-06	3.054	1.454E-06	3.271	1.823E-06	3.450	2.593E-06
3.608	3.851E-06	3.789	5.997E-06	3.920	8.355E-06	4.040	1.109E-05

h. T= 2293^{o}K

λ	k	λ	k	λ	k	λ	k
1.973	1.143E-06	2.206	1.229E-06	2.404	1.310E-06	2.584	1.417E-06
2.816	1.597E-06	3.032	1.837E-06	3.281	2.356E-06	3.451	3.085E-06
3.618	4.710E-06	3.809	7.897E-06	3.997	1.249E-05	4.214	2.078E-05
4.423	3.308E-05	4.563	5.447E-05	4.902	8.522E-05	5.120	1.231E-04
5.376	1.863E-04	5.597	2.614E-04	5.793	3.460E-04		


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-2G
SAPPHIRE
T=1973 K
GRYUNAK, J. OPT. SOC. 55, 625 (1965)
REF. 1K-2
1E-3
1E-4
1E-5
1E-6
1E-7
EXTINCTION INDEX, K
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20
22.5
25.
WAVELENGTH(MICRONS)

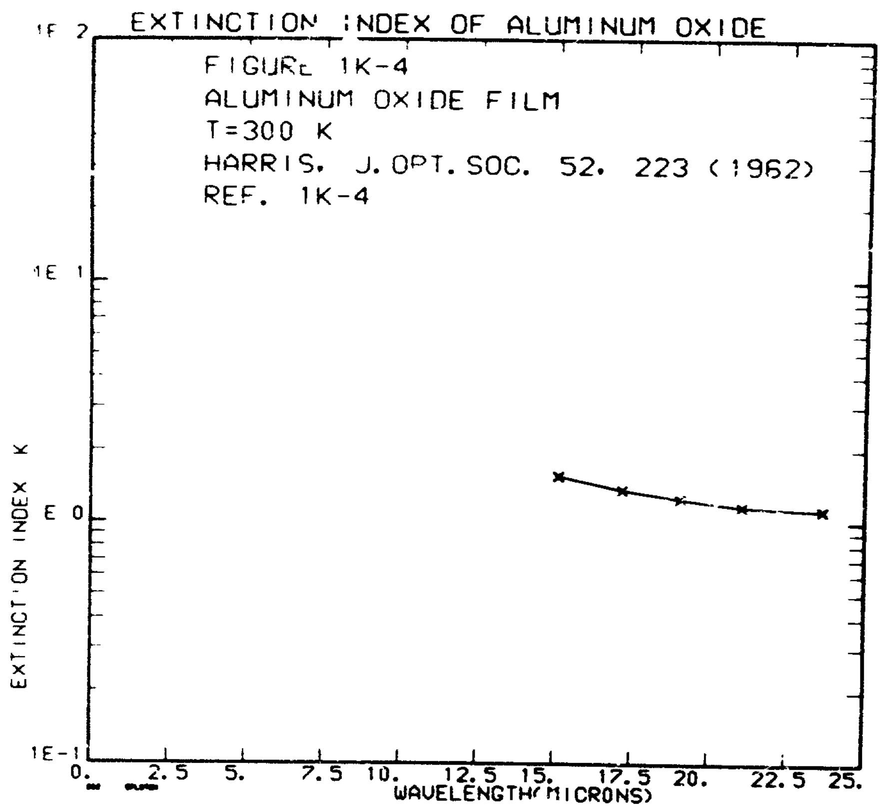

EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-2H
SAPPHIRE
GRYUNAK, J. OPT. SOC. 55, 625 (1965)
REF. 1K-2
1E-3
1E-4
1E-5
1E-6
1E-7
EXTINCTION INDEX, K
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)

Harris (Ref. 1K-4)

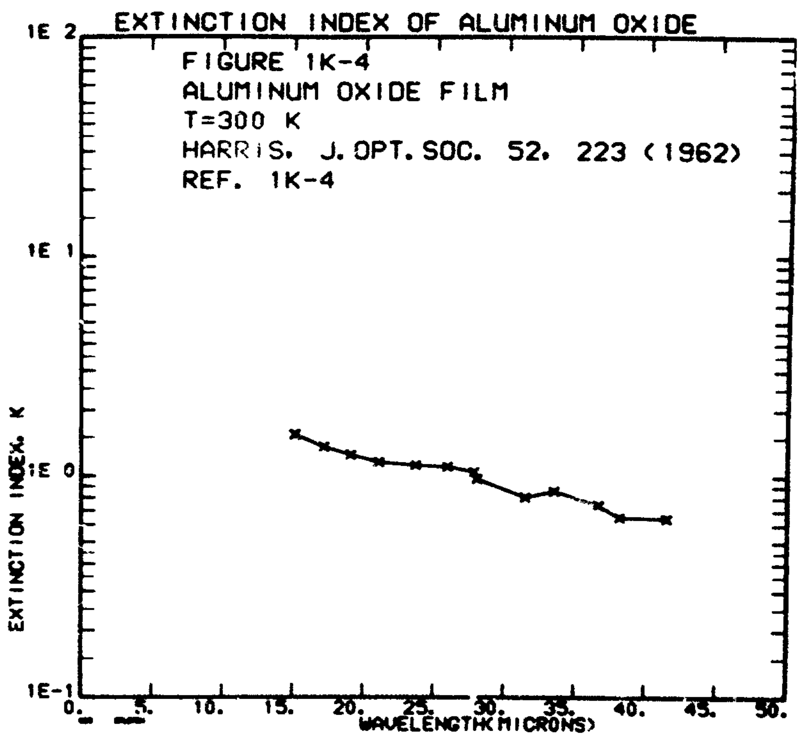
The extinction index of aluminum oxide films of 200 to 2800 Å thickness was determined using a grating spectrograph to measure transmittance. No spectrometer bandpass or experimental error estimate was given. Data were digitized from a line.

No representative curve for film was constructed.

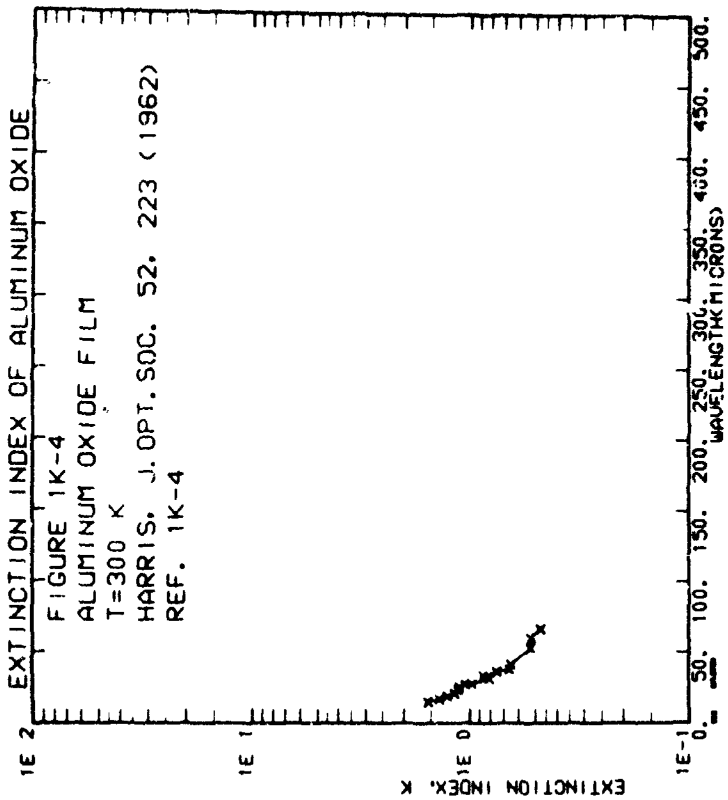
λ	k	λ	k	λ	k	λ	k
15.108	1.550E+00	17.193	1.367E+00	19.063	1.260E+00	21.056	1.166E+00
23.662	1.126E+00	25.927	1.112E+00	27.810	1.050E+00	28.020	9.730E-01
31.474	8.053E-01	33.512	8.583E-01	36.679	7.412E-01	36.679	7.412E-01
38.169	6.501E-01	41.507	6.413E-01	53.415	5.265E-01	60.520	5.242E-01
66.532	4.712E-01						



EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-4
ALUMINUM OXIDE FILM
T=300 K
HARRIS. J. OPT. SOC. 52. 223 (1962)
REF. 1K-4
1E 2
1E 1
E 0
1E-1
EXTINCTION INDEX K
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
WAVELENGTH(MICRONS)



EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-4
ALUMINUM OXIDE FILM
T=300 K
HARRIS. J. OPT. SOC. 52. 223 (1962)
REF. 1K-4
1E 2
1E 1
1E 0
1E-1
EXTINCTION INDEX. K
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
WAVELENGTH(MICRONS)


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-4
ALUMINUM OXIDE FILM
T=300 K
HARRIS, J.OPT.SOC. 52, 223 (1962)
REF. 1K-4
EXTINCTION INDEX, K
WAVELENGTH(MICRONS)
1E 2
1E 1
1E 0
1E-1
0.
50.
100.
150.
200.
250.
300.
350.
400.
450.
500.

Loewenstein (Ref. 1K-5)

Long wavelength extinction index measurements were made on sapphire at T = 1.5°K and 300°K using a far infrared Michaelson interferometer. The sapphire purity was not given, but no differences in k_o or k_e were observed between the sapphire and ruby containing 0.9 percent Cr, 0.05 percent Fe and Ti, and less than 0.001 percent of other impurities. No spectral bandpass information was given. Uncertainty in k is ±10 percent for T = 300°K, and ±0.3 at 1.5°K. Data were taken from tables.

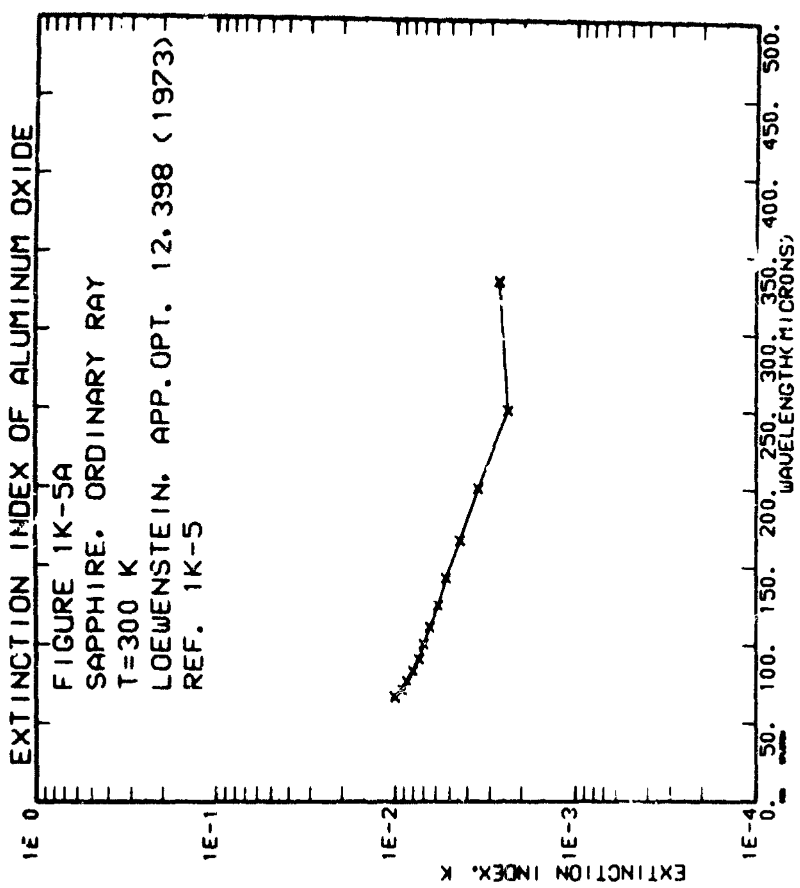
These data were selected to construct the representative curve of Section I, Figure I - 1.2.

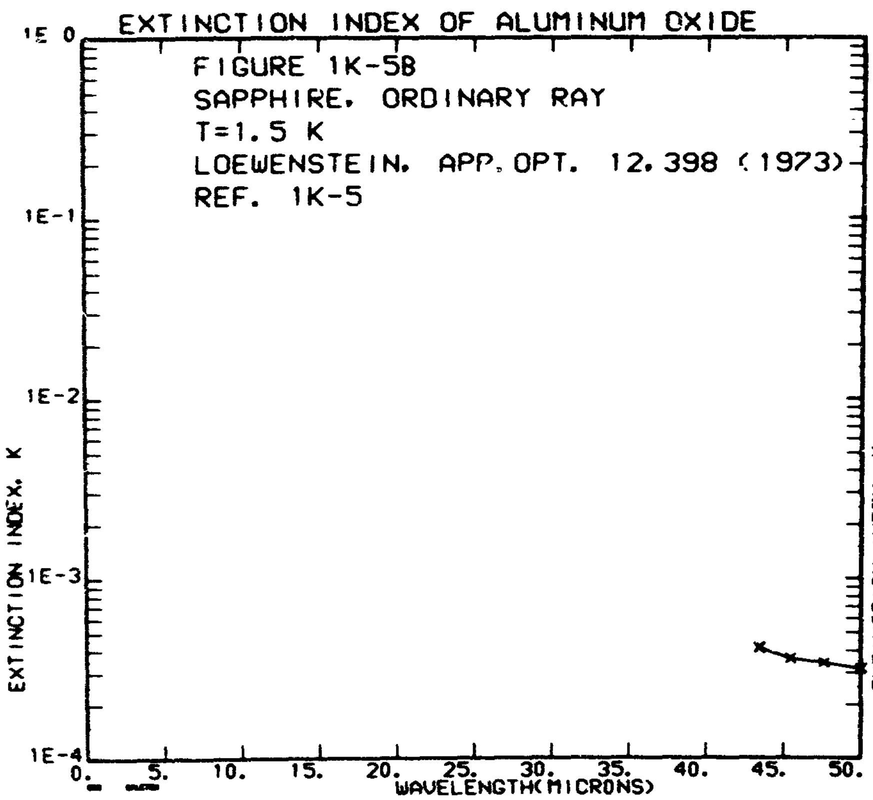
a. Ordinary Ray, T = 300°K

λ	k	λ	k	λ	k
333.333	2.653E-03	250.000	2.387E-03	200.000	3.501E-03
166.667	4.377E-03	142.857	5.229E-03	125.000	5.769E-03
111.111	6.455E-03	100.000	6.923E-03	90.909	7.379E-03
83.333	7.958E-03	76.923	8.570E-03	71.429	9.095E-03
66.667	1.008E-02				

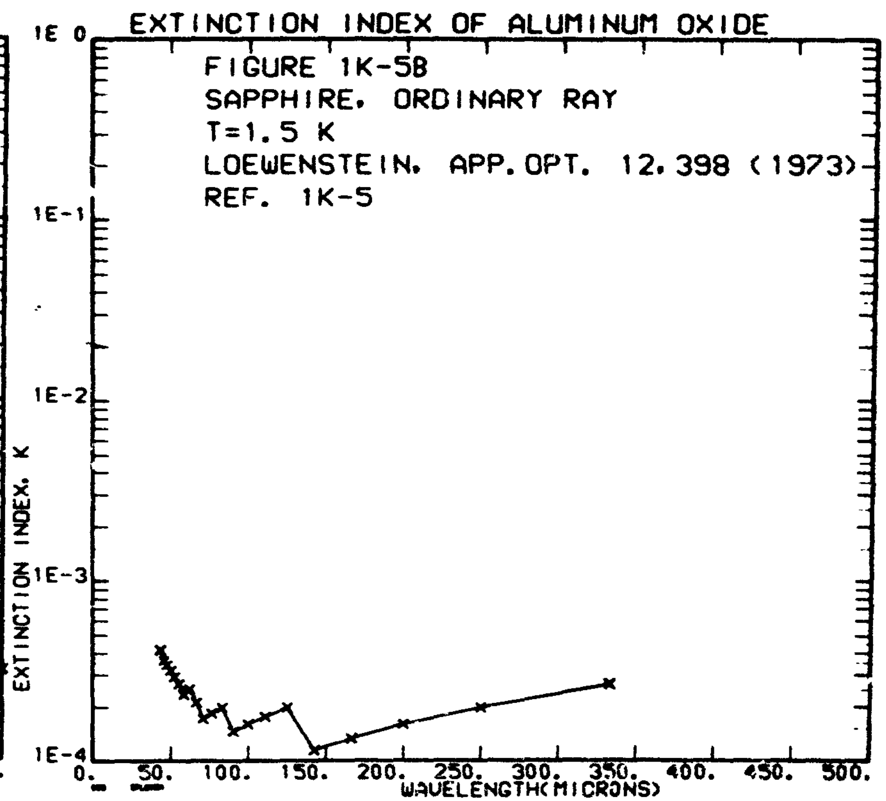
b. Ordinary Ray, T = 1.5°K

λ	k	λ	k	λ	k
333.333	2.653E-04	250.000	1.989E-04	200.000	1.592E-04
166.667	1.326E-04	142.857	1.137E-04	125.000	1.989E-04
111.111	1.708E-04	100.000	1.592E-04	90.909	1.447E-04
83.333	1.989E-04	76.923	1.836E-04	71.429	1.705E-04
66.667	2.122E-04	62.500	2.487E-04	58.824	2.341E-04
55.556	2.653E-04	52.632	2.932E-04	50.000	3.183E-04
47.619	3.410E-04	45.455	3.617E-04	43.478	4.152E-04


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-5A
SAPPHIRE. ORDINARY RAY
T=300 K
LOEWENSTEIN. APP.OPT. 12.398 (1973)
REF. 1K-5
1E 0
1E-1
1E-2
1E-3
1E-4
EXTINCTION INDEX, K
0.
50.
100.
150.
200.
250.
300.
350.
400.
450.
500.
WAVELENGTH(MICRONS)



EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-5B
SAPPHIRE, ORDINARY RAY
T=1.5 K
LOEWENSTEIN, APP. OPT. 12, 398 (1973)
REF. 1K-5
EXTINCTION INDEX, K
1E 0
1E-1
1E-2
1E-3
1E-4
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.



EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-5B
SAPPHIRE, ORDINARY RAY
T=1.5 K
LOEWENSTEIN, APP. OPT. 12, 398 (1973)
REF. 1K-5
EXTINCTION INDEX, K
1E 0
1E-1
1E-2
1E-3
1E-4
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.

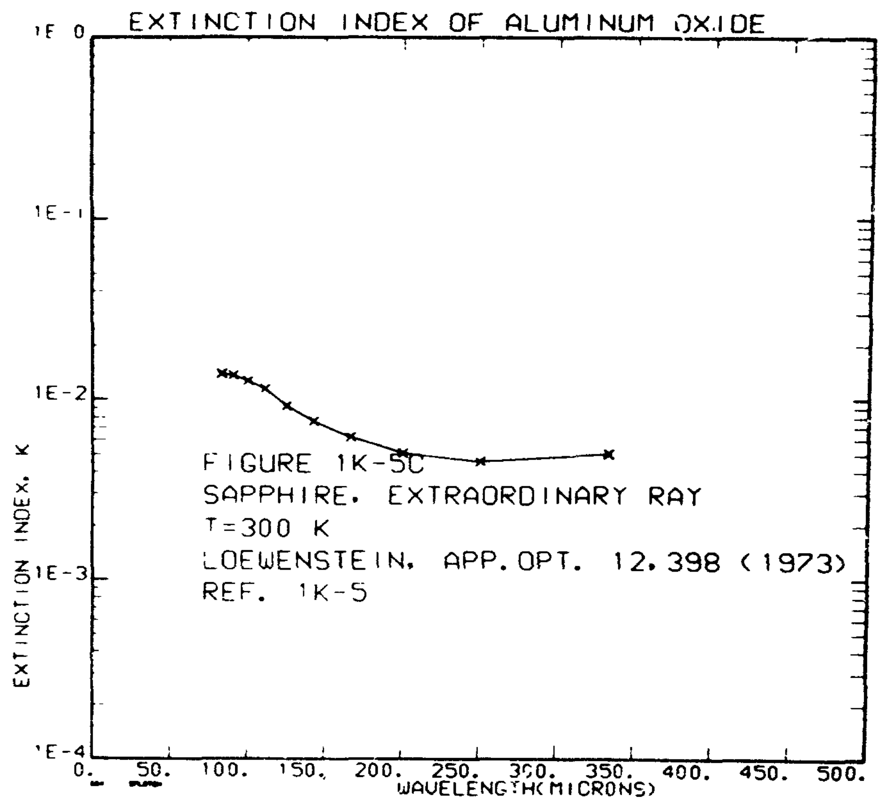
Loewenstein (Ref. 1K-5)

c. Extraordinary ray, T = 300°K

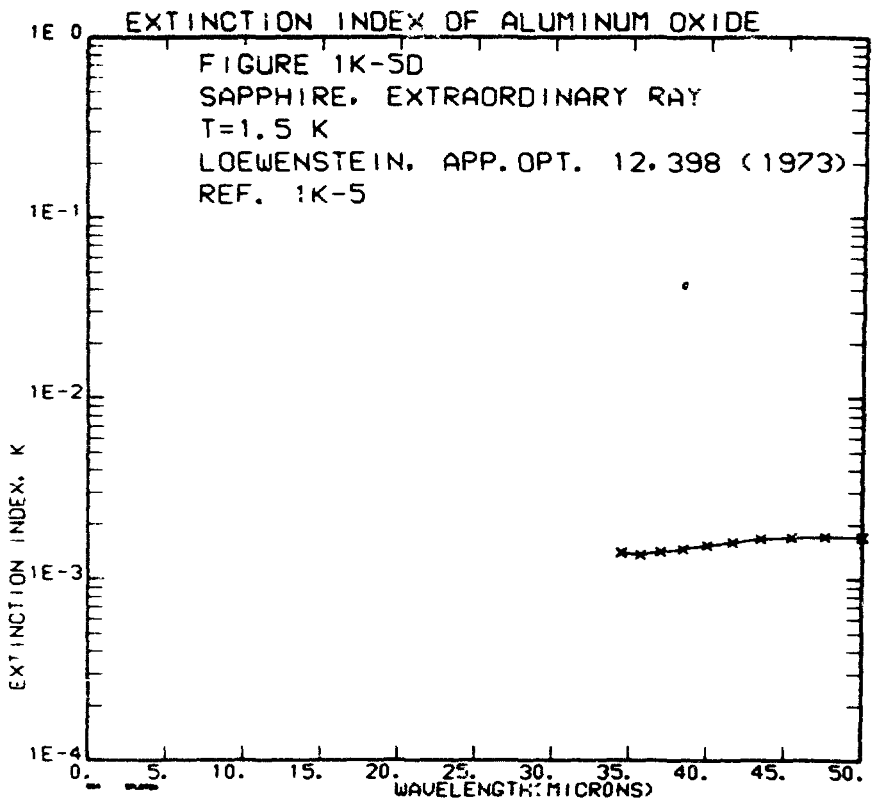
λ	k	λ	k	λ	k
333.333	5.040E-03	250.000	4.576E-03	200.000	5.093E-03
166.667	6.234E-03	142.857	7.617E-03	125.000	9.251E-03
111.111	1.149E-02	100.000	1.273E-02	90.909	1.375E-02
83.333	1.393E-02				

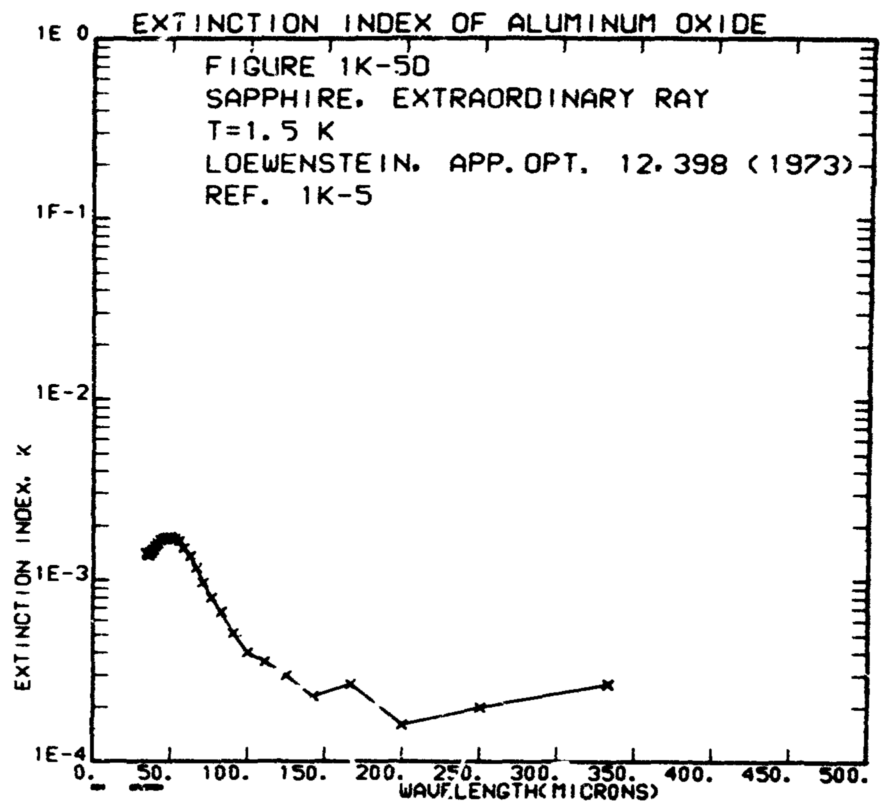
d. Extraordinary ray, T = 1.5°K

λ	k	λ	k	λ	k
333.333	2.653E-04	250.000	1.989E-04	200.000	1.592E-04
166.667	2.653E-04	142.857	2.274E-04	125.000	2.984E-04
111.111	3.537E-04	100.000	3.979E-04	90.909	5.064E-04
83.333	6.631E-04	76.923	7.958E-04	71.429	9.663E-04
66.667	1.167E-03	62.500	1.343E-03	58.824	1.498E-03
55.556	1.636E-03	52.632	1.675E-03	50.000	1.711E-03
47.619	1.705E-03	45.455	1.700E-03	43.478	1.661E-03
41.667	1.592E-03	40.000	1.528E-03	38.462	1.469E-03
37.337	1.415E-03	35.714	1.364E-03	34.483	1.399E-03



EXTINCTION INDEX OF ALUMINUM OXIDE
1E 0
1E-1
1E-2
1E-3
1E-4
EXTINCTION INDEX, K
0.
50.
100.
150.
200.
250.
300.
350.
400.
450.
500.
WAVELENGTH(MICRONS)
FIGURE 1K-5C
SAPPHIRE. EXTRAORDINARY RAY
T=300 K
LOEWENSTEIN. APP.OPT. 12.398 (1973)
REF. 1K-5


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-5D
SAPPHIRE, EXTRAORDINARY RAY
T=1.5 K
LOEWENSTEIN, APP.OPT. 12,398 (1973)
REF. 1K-5
EXTINCTION INDEX, K
WAVELENGTH(MICRONS)
1E 0
1E-1
1E-2
1E-3
1E-4
0.
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-5D
SAPPHIRE, EXTRAORDINARY RAY
T=1.5 K
LOEWENSTEIN, APP.OPT. 12,398 (1973)
REF. 1K-5
EXTINCTION INDEX, K
WAVELENGTH(MICRONS)
1E 0
1F-1
1E-2
1E-3
1E-4
0.
50.
100.
150.
200.
250.
300.
350.
400.
450.
500.

Mergerian (Ref. 1K-6)

The absorption coefficient of synthetic sapphire was measured using a Perkin-Elmer monochromator with an unspecified bandpass, at temperatures ranging from 373 to 1273°K. No error analysis was given. Data were digitized from specific points.

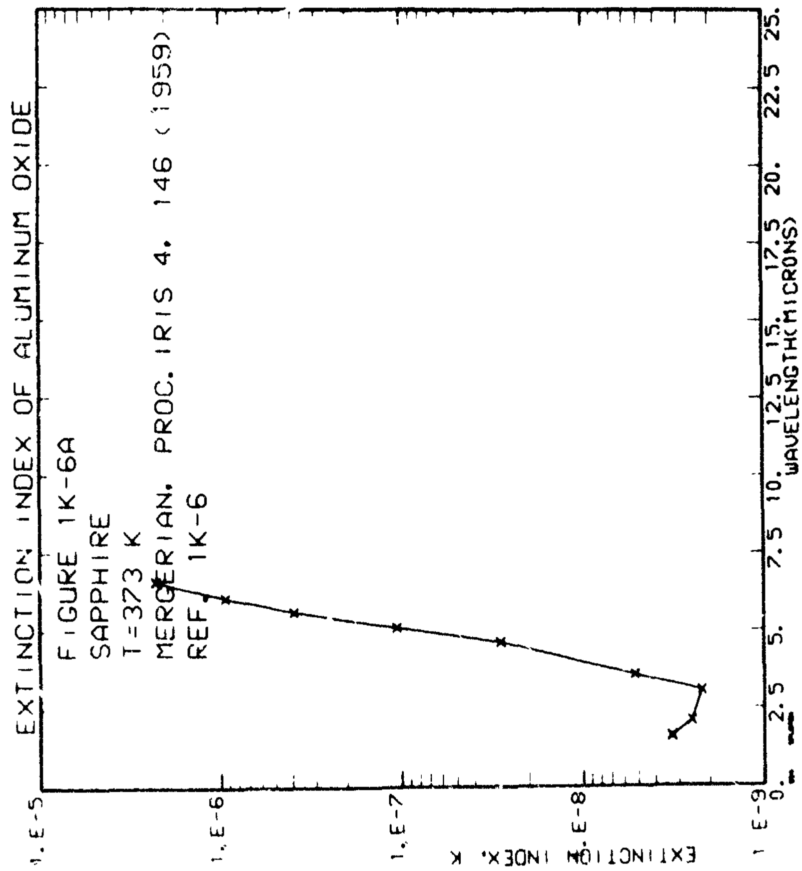
These data range from very much lower than the representative curve of Section I ($\lambda < 4\ \mu$) to good agreement (at 5 to 6 μ).

a. T = 373°K

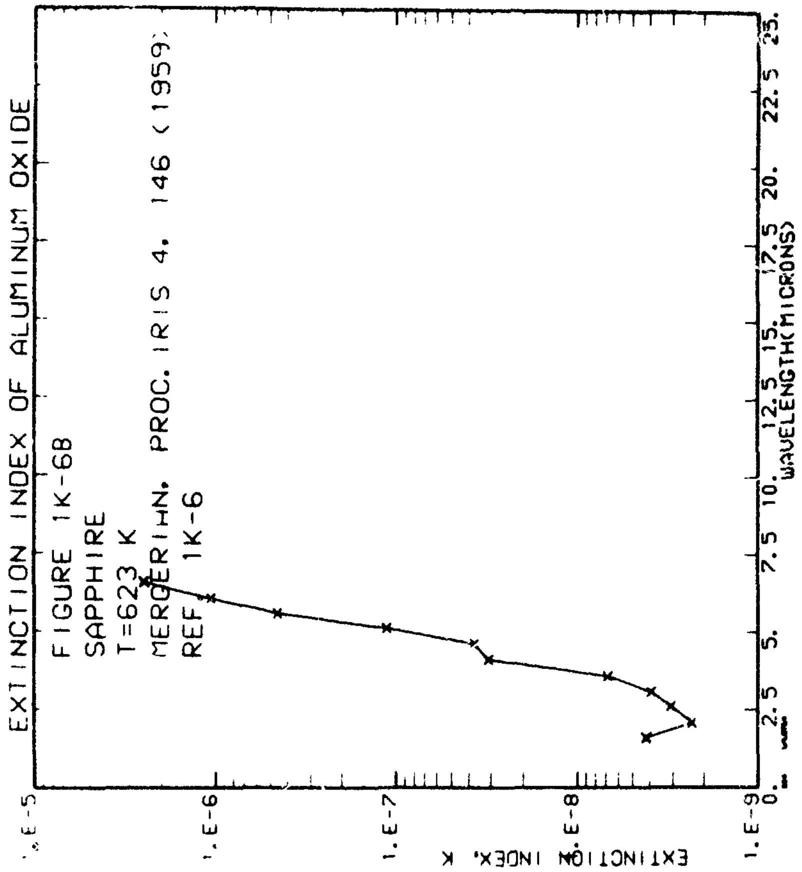
λ	k	λ	k	λ	k	λ	k
1.009	3.257E-09	1.514	2.524E-09	2.477	2.209E-09	2.990	5.230E-09
4.033	2.838E-08	4.517	1.061E-07	5.004	3.911E-07	5.471	9.380E-07
5.985	2.292E-06						

b. T = 623°K

λ	k	λ	k	λ	k	λ	k
1.031	4.133E-09	1.475	2.313E-09	2.003	3.046E-09	2.485	3.898E-09
2.989	6.806E-09	3.521	3.100E-08	4.010	3.722E-08	4.505	1.128E-07
4.990	4.542E-07	5.466	1.067E-06	5.994	2.508E-06		



EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-6A
SAPPHIRE
T=373 K
MERGERIAN. PROC. IRIS 4. 146 (1959)
REF. 1K-6
EXTINCTION INDEX, K
1.E-5
1.E-6
1.E-7
1.E-8
1.E-9
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
WAVELENGTH(MICRONS)



EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-6B
SAPPHIRE
T=623 K
MERGERIAN. PROC. IRIS 4. 146 (1959)
REF. 1K-6
EXTINCTION INDEX, K
1.E-5
1.E-6
1.E-7
1.E-8
1.E-9
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
WAVELENGTH(MICRONS)

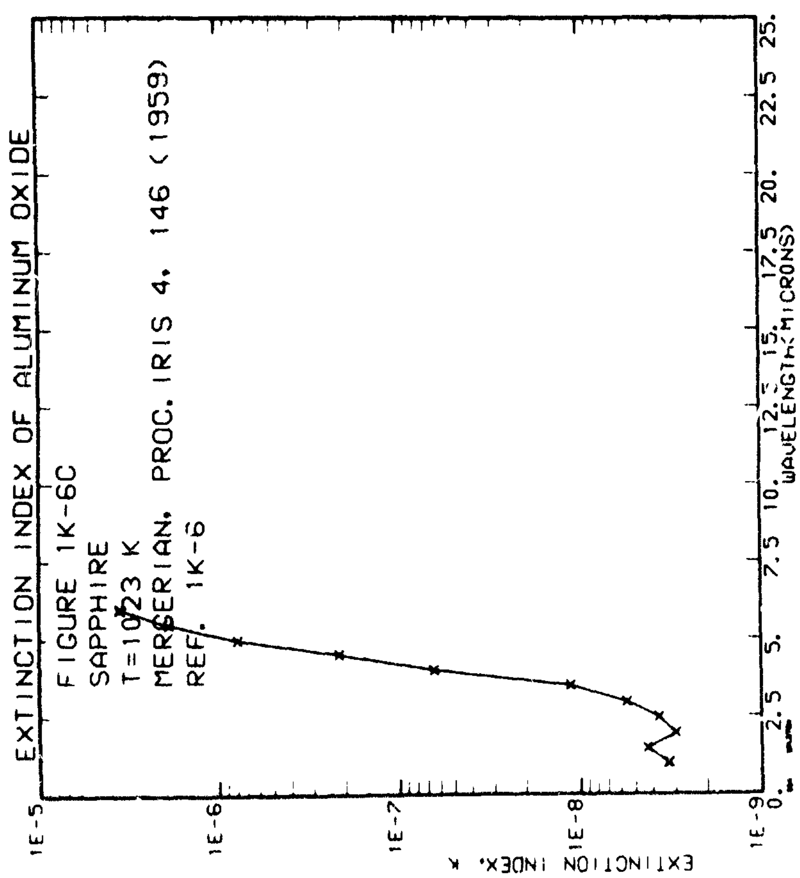
Mergerian (Ref. 1K-6)

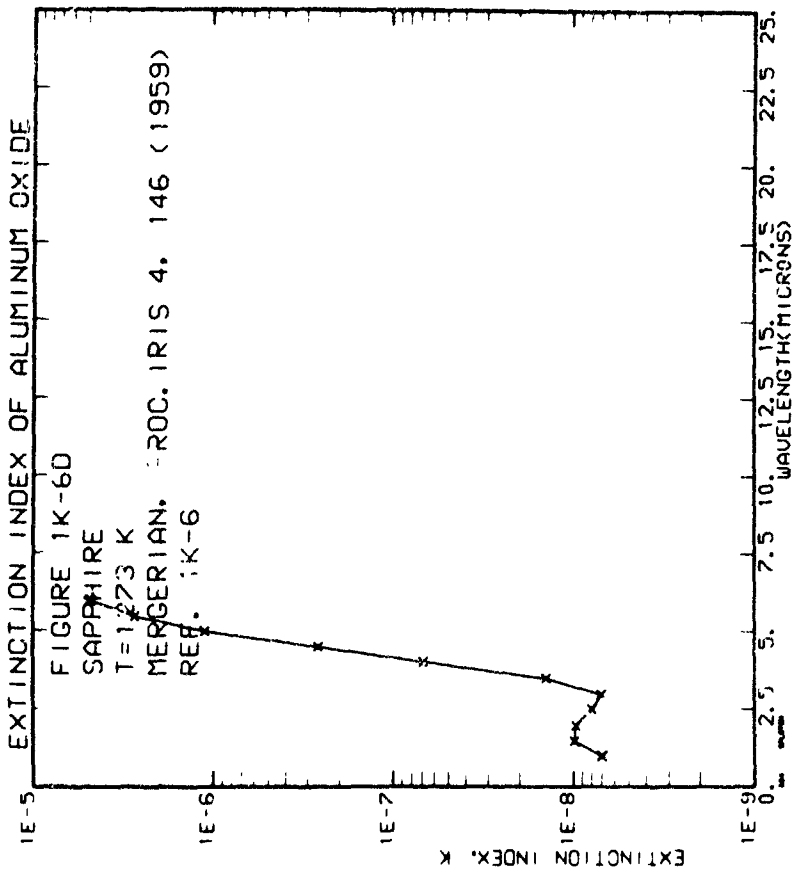
c. T = 1023°K

λ	k	λ	k	λ	k	λ	k
1.011	3.273E-09	1.488	4.260E-09	1.961	2.971E-09	2.494	3.692E-09
2.990	5.530E-09	3.498	1.129E-08	4.013	6.453E-08	4.513	2.161E-07
4.980	7.922E-07	5.473	1.895E-05	5.987	3.576E-06		

d. T = 1273°K

λ	k	λ	k	λ	k	λ	k
1.002	6.919E-09	1.493	9.969E-09	1.976	9.694E-09	2.501	7.910E-09
2.983	7.019E-09	3.494	1.422E-08	4.009	6.888E-08	4.493	2.614E-07
4.975	1.112E-06	5.457	2.724E-06	5.972	4.814E-05		


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-6C
SAPPHIRE
T=1023 K
MERGERIAN. PROC. IRIS 4. 146 (1959)
REF. 1K-6
EXTINCTION INDEX, K
1E-5
1E-6
1E-7
1E-8
1E-9
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

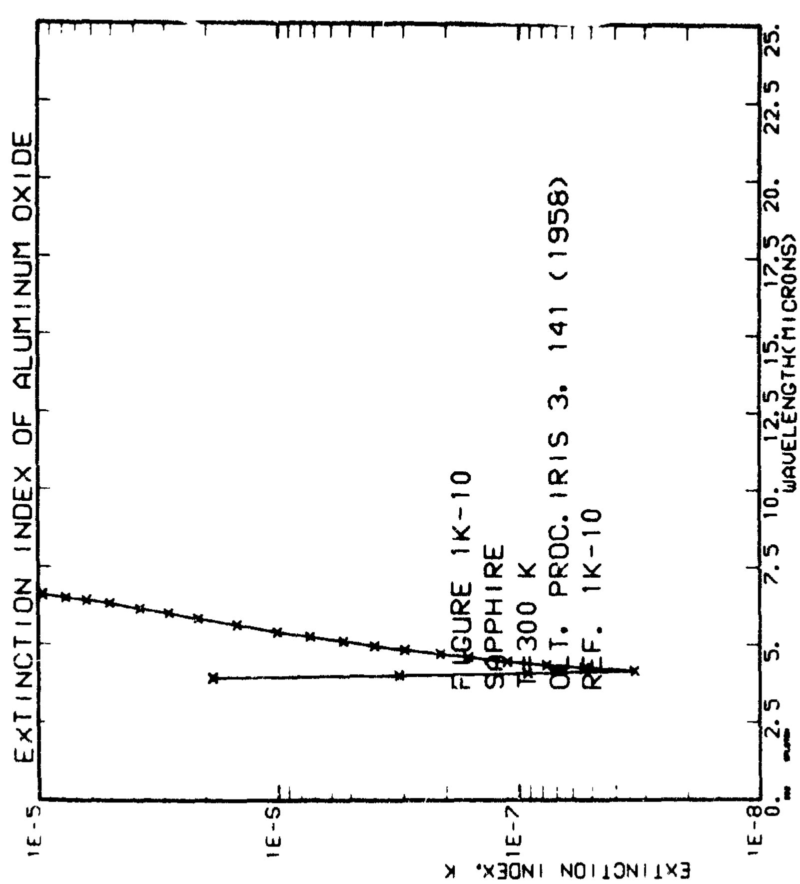

EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-6D
SAPPHIRE
T=1273 K
MERGERIAN. PROC. IRIS 4. 146 (1959)
REF. 1K-6
EXTINCTION INDEX, K
1E-5
1E-6
1E-7
1E-8
1E-9
WAVELENGTH(MICRONS)
0.
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

Olt (Ref. 1K-10)

The absorption coefficient for clear Linde sapphire as measured by Beardsley is given. No error analyses or other experimental details are given. Digitized from a continuous curve.

These values are much lower than the representative curve of Section I - 1.2.

λ	k	λ	k	λ	k	λ	k
3.931	1.668E-06	4.014	3.119E-07	4.081	9.240E-08	4.161	3.317E-08
4.264	5.325E-08	4.355	7.629E-08	4.472	1.111E-07	4.601	1.611E-07
4.702	2.116E-07	4.838	2.951E-07	4.965	3.943E-07	5.105	5.335E-07
5.258	7.318E-07	5.416	1.007E-06	5.627	1.479E-06	5.840	2.150E-06
6.004	2.845E-06	6.160	3.726E-06	6.325	5.030E-06	6.435	6.289E-06
6.517	7.643E-06	6.609	9.629E-06				


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-10
SAPPHIRE
T=300 K
OPT. PROC. IRIS 3. 141 (1958)
REF. 1K-10
EXTINCTION INDEX, K
1E-5
1E-6
1E-7
1E-8
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

Oppenheim (Ref. 1K-11)

A Perkin-Elmer 12G spectrometer with unspecified bandpass was used to measure the absorption coefficient of synthetic Meller Co. sapphire from 3μ to 6μ at temperatures ranging from 293 to 1273°K. The estimated accuracy of the data is 3 percent. The data were digitized from lines.

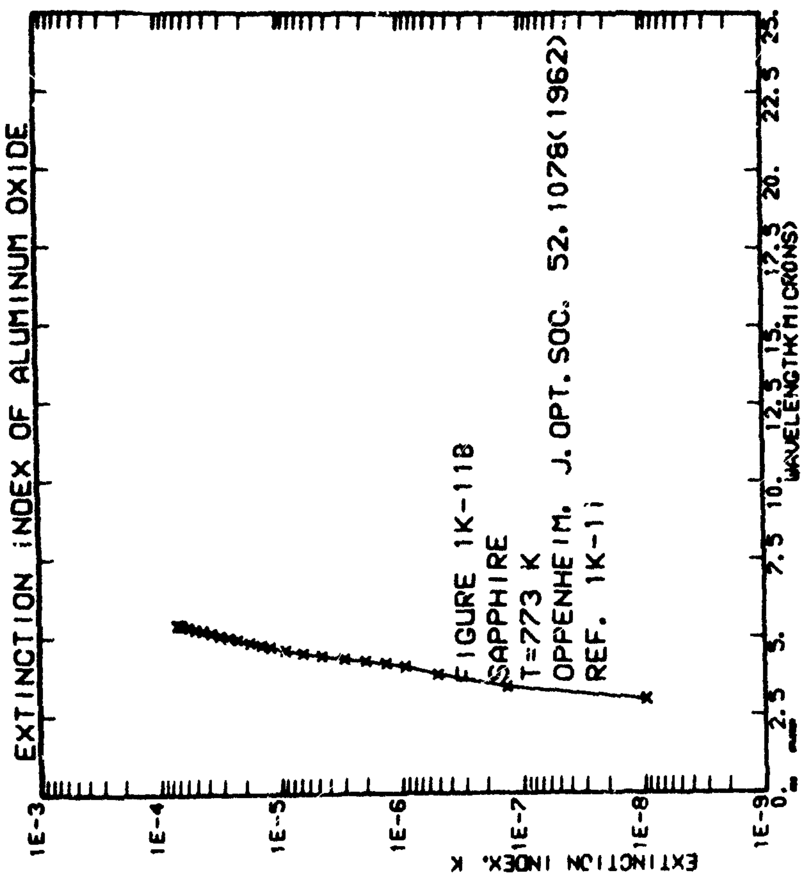
These values are slightly higher than the representative curve of Section I - 1.2.

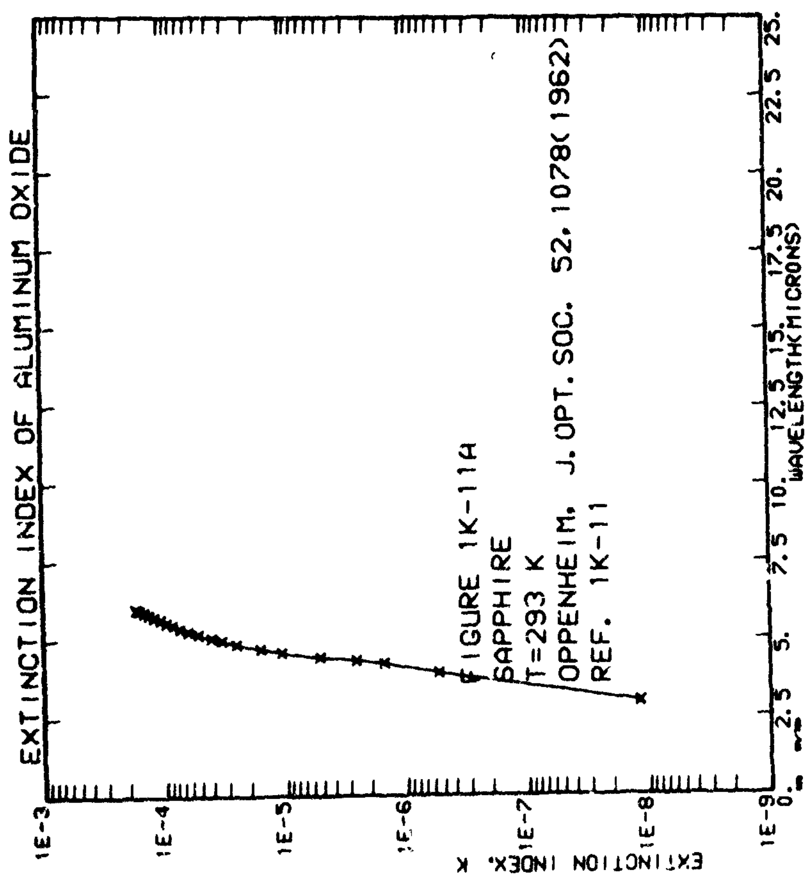
a. T = 293°K

λ	k	λ	k	λ	k	λ	k
3.000	1.194E-08	3.940	5.487E-07	4.239	1.552E-06	4.332	2.620E-06
4.446	5.169E-06	4.591	1.078E-05	4.703	1.608E-05	4.862	2.553E-05
4.976	3.363E-05	5.069	4.078E-05	5.190	5.212E-05	5.297	6.352E-05
5.397	7.464E-05	5.482	8.590E-05	5.572	9.733E-05	5.649	1.088E-04
5.740	1.231E-04	5.810	1.353E-04	5.878	1.483E-04	5.953	1.634E-04
5.990	1.716E-04						

b. T = 773°K

λ	k	λ	k	λ	k	λ	k
3.000	9.549E-09	3.412	1.358E-07	3.819	5.045E-07	4.067	9.386E-07
4.158	1.343E-06	4.237	2.020E-06	4.319	2.997E-06	4.409	4.565E-06
4.496	6.544E-06	4.597	9.204E-06	4.679	1.203E-05	4.748	1.443E-05
4.828	1.801E-05	4.928	2.294E-05	4.994	2.693E-05	5.066	3.199E-05
5.134	3.729E-05	5.203	4.418E-05	5.269	5.078E-05	5.326	5.739E-05
5.385	6.514E-05	5.399	6.698E-05	5.414	7.092E-05		


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-11B
SAPPHIRE
T=773 K
OPPENHEIM. J. OPT. SOC. 52. 1078(1962)
REF. 1K-11
EXTINCTION INDEX, K
1E-3
1E-4
1E-5
1E-6
1E-7
1E-8
1E-9
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-11A
SAPPHIRE
T=293 K
OPPENHEIM. J. OPT. SOC. 52. 1078(1962)
REF. 1K-11
EXTINCTION INDEX, K
1E-3
1E-4
1E-5
1E-6
1E-7
1E-8
1E-9
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

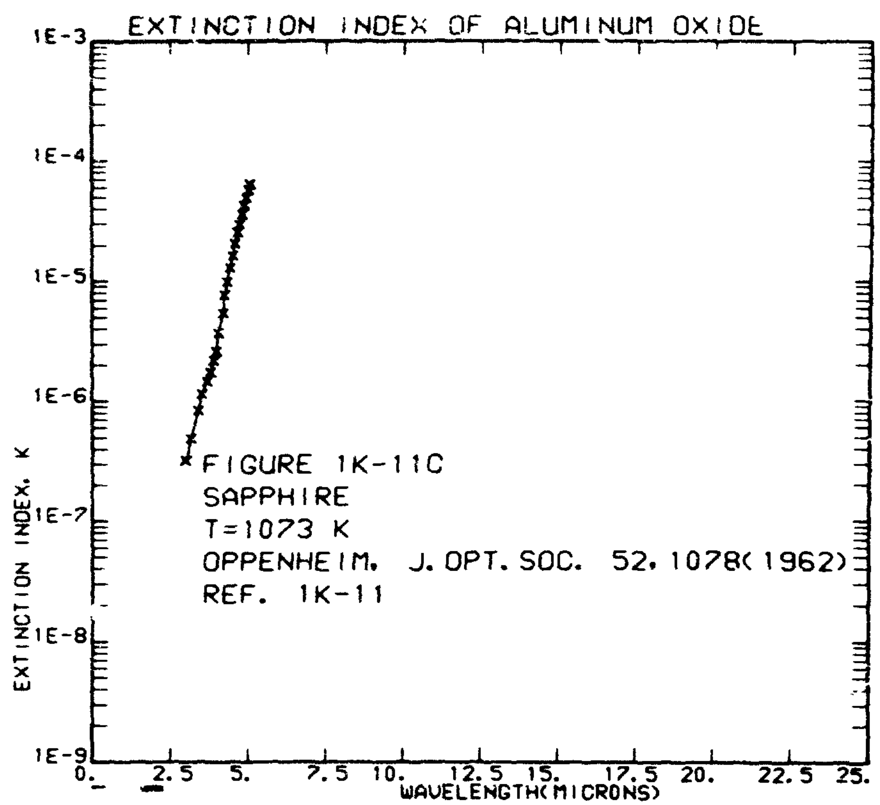
Oppenheim (Ref. 1K-11)

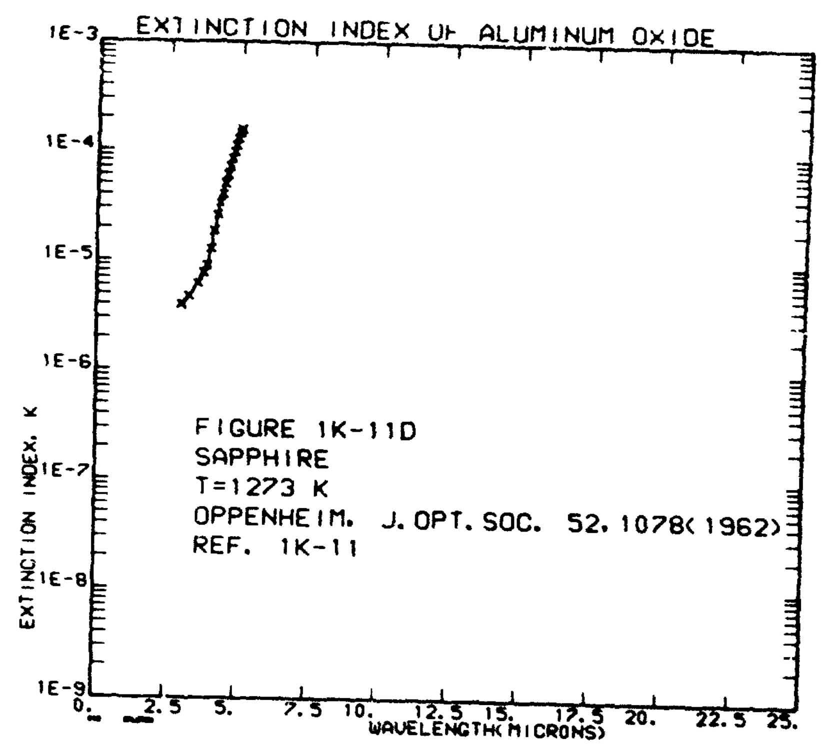
c. $T = 1073^{o}K$

λ	k	λ	k	λ	k	λ	k
3.001	3.209E-07	3.179	4.908E-07	3.402	8.365E-07	3.542	1.153E-06
3.690	1.462E-06	3.810	1.752E-06	3.904	2.172E-06	3.981	2.617E-06
4.072	3.704E-06	4.200	5.431E-06	4.267	7.701E-06	4.340	9.867E-06
4.428	1.296E-05	4.510	1.646E-05	4.596	2.080E-05	4.673	2.537E-05
4.736	2.960E-05	4.816	3.582E-05	4.889	4.280E-05	4.952	4.973E-05
5.012	5.739E-05	5.064	6.472E-05				

d. $T = 1273^{o}K$

λ	k	λ	k	λ	k	λ	k
3.441	3.955E-06	3.241	4.787E-06	3.571	6.255E-06	3.766	7.630E-06
3.864	8.966E-06	3.977	1.271E-05	4.097	1.859E-05	4.206	2.599E-05
4.296	3.318E-05	4.369	4.002E-05	4.457	4.987E-05	4.539	6.032E-05
4.617	7.216E-05	4.691	8.493E-05	4.756	9.783E-05	4.818	1.114E-04
4.892	1.302E-04	4.949	1.463E-04	4.993	1.585E-04		


EXTINCTION INDEX OF ALUMINUM OXIDE
EXTINCTION INDEX, K
1E-3
1E-4
1E-5
1E-6
1E-7
1E-8
1E-9
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)
FIGURE 1K-11C
SAPPHIRE
T=1073 K
OPPENHEIM. J. OPT. SOC. 52, 1078(1962)
REF. 1K-11


EXTINCTION INDEX OF ALUMINUM OXIDE
EXTINCTION INDEX, K
1E-3
1E-4
1E-5
1E-6
1E-7
1E-8
1E-9
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)
FIGURE 1K-11D
SAPPHIRE
T=1273 K
OPPENHEIM. J. OPT. SOC. 52, 1078(1962)
REF. 1K-11

Piriou (Ref. 1K-12)

The absorption coefficient of sapphire from 4μ to 11μ was measured at temperatures of $77^{o}K$ and $293^{o}K$. The experimental details were not given. Data were digitized from curves.

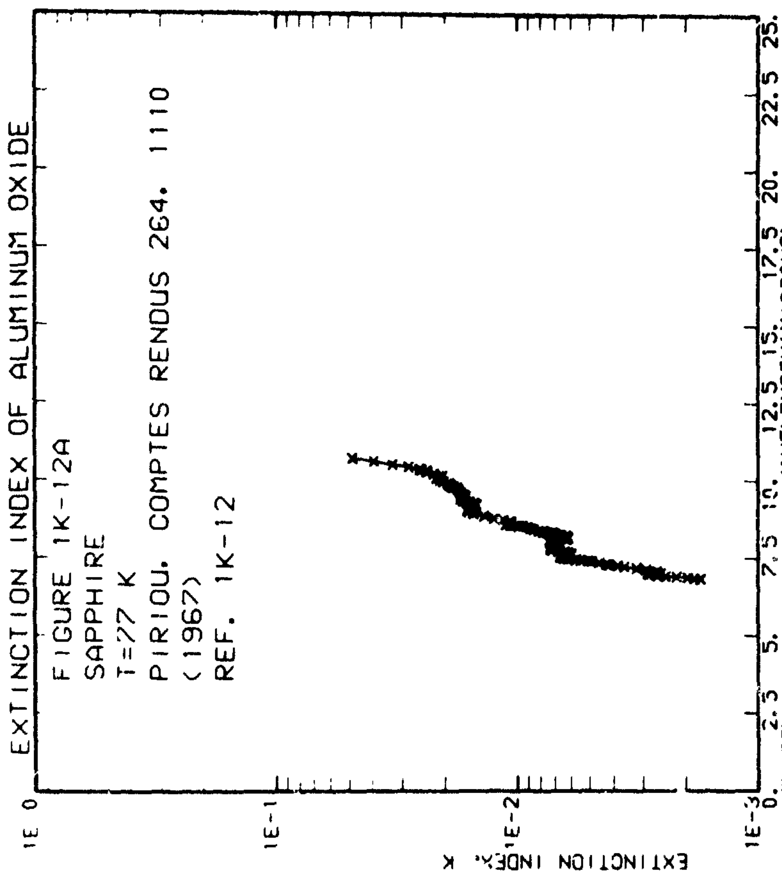
These data were selected to construct the representative curve of Section I, Figure I - 1.2.

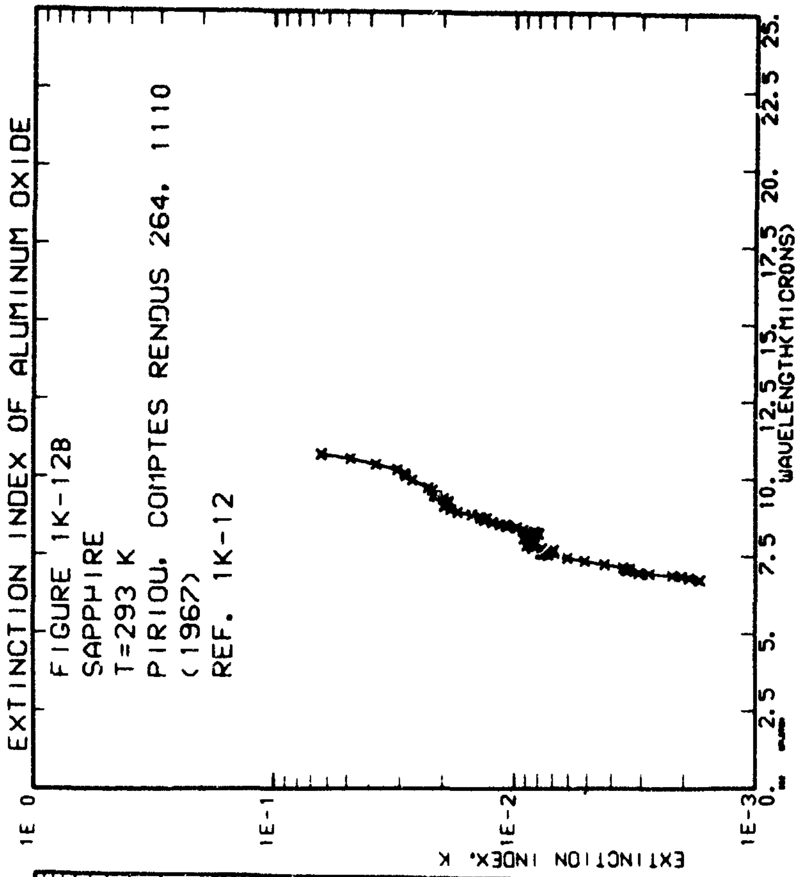
a. $T = 77^{o}K$

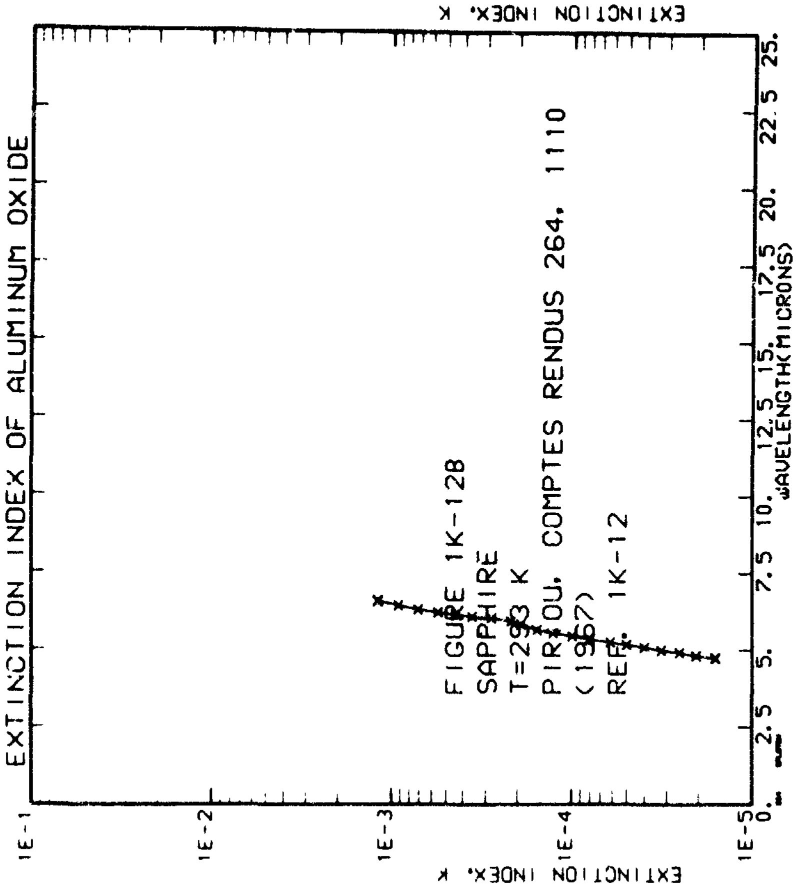
λ	k	λ	k	λ	k
10.705	4.843E-02	10.614	3.933E-02	10.516	3.293E-02
10.434	2.624E-02	10.360	2.540E-02	10.329	2.491E-02
10.318	2.376E-02	10.267	2.354E-02	10.202	2.217E-02
10.132	2.041E-02	10.103	2.111E-02	10.070	2.158E-02
10.010	2.077E-02	9.948	2.020E-02	9.905	1.932E-02
9.855	1.899E-02	9.819	1.876E-02	9.794	1.840E-02
9.754	1.778E-02	9.674	1.753E-02	9.611	1.718E-02
9.538	1.664E-02	9.509	1.650E-02	9.474	1.704E-02
9.445	1.653E-02	9.415	1.705E-02	9.397	1.720E-02
9.361	1.691E-02	9.333	1.652E-02	9.303	1.579E-02
9.280	1.506E-02	9.242	1.473E-02	9.193	1.507E-02
9.144	1.532E-02	9.090	1.581E-02	9.047	1.608E-02
8.984	1.592E-02	8.931	1.513E-02	8.859	1.365E-02
8.781	1.241E-02	8.728	1.138E-02	8.683	1.073E-02
8.657	1.055E-02	8.616	1.073E-02	8.576	1.107E-02
8.551	1.062E-02	8.528	9.875E-03	8.523	9.445E-03
8.508	9.038E-03	8.470	[illegible]	8.424	8.557E-03
8.393	8.147E-03	8.366	7.796E-03	8.347	7.485E-03
8.328	7.119E-03	8.291	6.915E-03	8.259	6.623E-03
8.234	6.280E-03	8.195	6.160E-03	8.167	6.184E-03
8.140	6.319E-03	8.095	6.772E-03	8.065	7.088E-03
8.027	7.209E-03	8.011	7.222E-03	7.983	7.022E-03
7.954	6.847E-03	7.927	6.683E-03	7.901	6.870E-03
7.874	7.104E-03	7.836	7.286E-03	7.799	7.279E-03
7.768	7.167E-03	7.737	6.764E-03	7.704	6.362E-03
7.691	6.150E-03	7.649	5.977E-03	7.622	6.084E-03
7.600	6.339E-03	7.578	6.630E-03	7.547	6.663E-03
7.517	6.426E-03	7.489	6.160E-03	7.467	5.721E-03
7.447	5.404E-03	7.427	5.092E-03	7.409	4.922E-03
7.364	4.582E-03	7.316	4.286E-03	7.290	4.167E-03
7.262	3.840E-03	7.224	3.589E-03	7.174	3.201E-03
7.133	2.930E-03	7.081	2.644E-03	7.044	2.525E-03
7.033	2.624E-03	7.028	2.796E-03	7.009	2.888E-03
6.981	2.820E-03	6.958	2.613E-03	6.932	2.417E-03
6.913	2.167E-03	6.893	1.965E-03	6.870	1.844E-03
6.836	1.728E-03				

b. T = 293°K

λ	k	λ	k	λ	k
10.758	6.327E-02	10.603	4.808E-02	10.438	3.747E-02
10.272	3.071E-02	10.140	2.856E-02	10.052	2.827E-02
9.946	2.648E-02	9.681	2.276E-02	9.598	2.189E-02
9.447	2.154E-02	9.399	2.092E-02	9.339	1.967E-02
9.266	1.873E-02	9.212	1.892E-02	9.128	1.930E-02
9.096	1.961E-02	8.988	1.841E-02	8.920	1.721E-02
8.825	1.498E-02	8.743	1.372E-02	8.701	1.304E-02
8.657	1.324E-02	8.592	1.234E-02	8.522	1.152E-02
8.496	1.090E-02	8.452	1.075E-02	8.406	9.801E-03
8.347	9.214E-03	8.274	8.225E-03	8.232	8.003E-03
8.204	7.384E-03	8.125	9.273E-03	8.085	8.816E-03
8.059	9.115E-03	8.009	8.660E-03	7.937	8.523E-03
7.869	8.614E-03	7.834	8.878E-03	7.772	8.336E-03
7.729	7.714E-03	7.685	6.886E-03	7.658	6.979E-03
7.633	7.376E-03	7.595	7.787E-03	7.559	7.607E-03
7.526	7.283E-03	7.438	6.039E-03	7.337	5.119E-03
7.244	4.247E-03	7.127	3.538E-03	7.080	3.332E-03
7.050	3.481E-03	7.024	3.409E-03	6.970	3.068E-03
6.941	2.781E-03	6.885	2.236E-03	6.855	2.028E-03
6.798	1.896E-03	6.728	1.717E-03		
6.596	1.183E-03	6.437	9.153E-04	6.315	7.096E-04
6.220	5.515E-04	6.162	4.362E-04	6.097	3.545E-04
6.025	2.781E-04	5.923	2.169E-04	5.835	1.916E-04
5.671	1.553E-04	5.559	1.276E-04	5.448	9.956E-05
5.[illegible]6	6.003E-05	5.263	6.176E-05	5.174	4.972E-05
5.098	3.989E-05	5.011	3.233E-05	4.924	2.552E-05
4.843	2.057E-05	4.765	1.626E-05		


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-12A
SAPPHIRE
T=77 K
PIRIOU. COMPTES RENDUS 264. 1110
(1967)
REF. 1K-12
EXTINCTION INDEX, K
WAVELENGTH(MICRONS)
1E 0
1E-1
1E-2
1E-3
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-12B
SAPPHIRE
T=293 K
PIRIOU, COMPTES RENDUS 264, 1110
(1967)
REF. 1K-12
EXTINCTION INDEX, K
1E 0
1E-1
1E-2
1E-3
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-12B
SAPPHIRE
T=293 K
PIRIOU, COMPTES RENDUS 264, 1110
(1967)
REF. 1K-12
EXTINCTION INDEX, K
1E-1
1E-2
1E-3
1E-4
1E-5
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

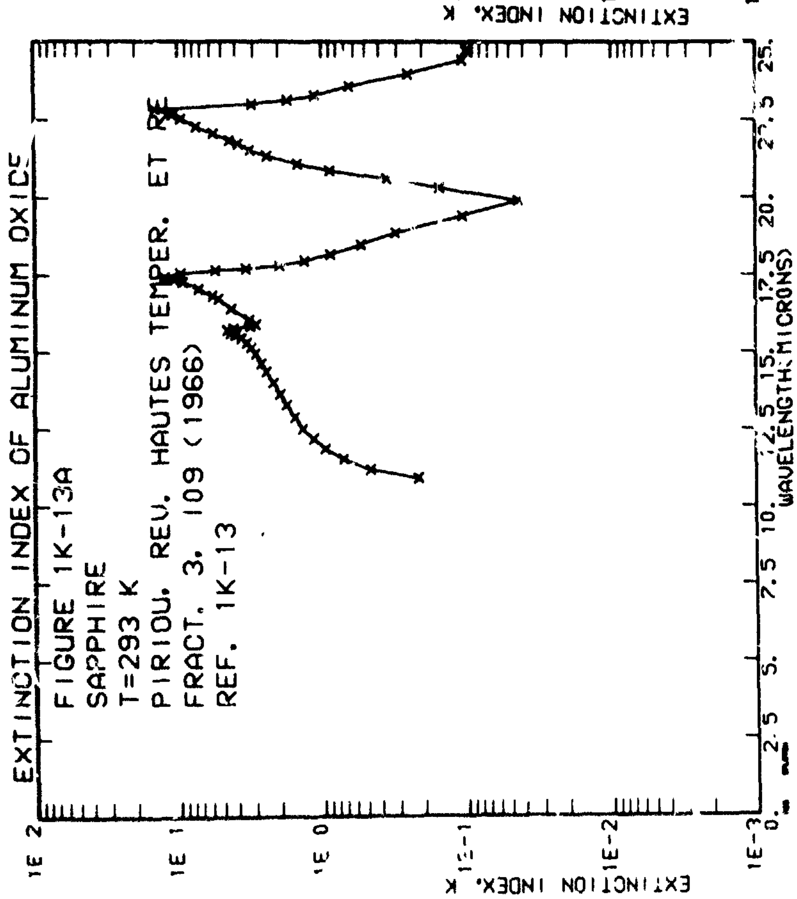
Piriou (Ref. 1K-13)

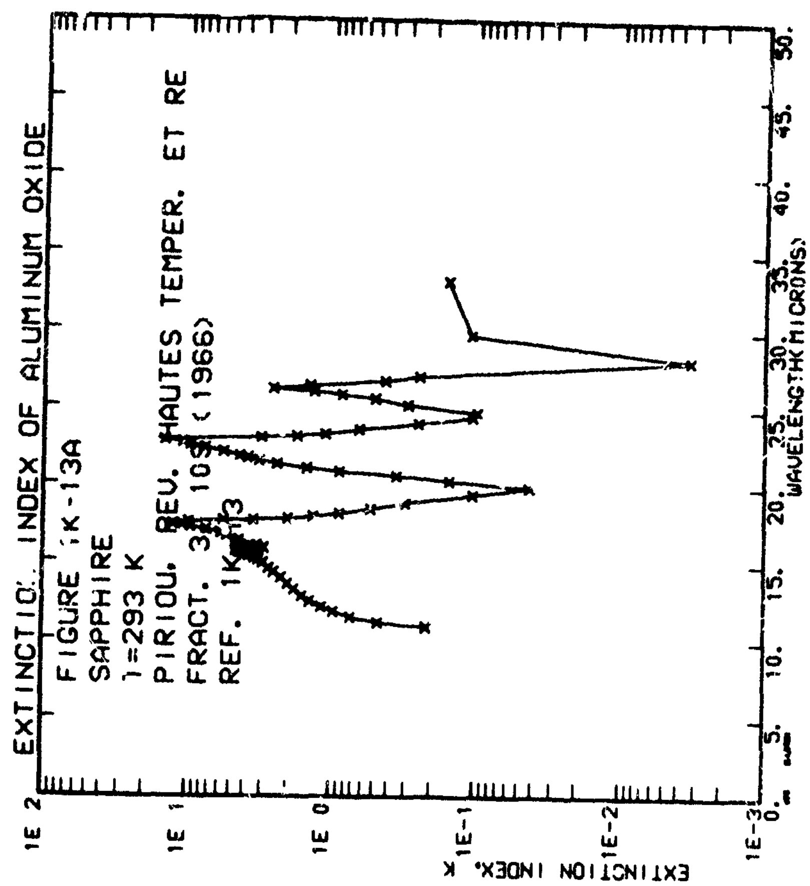
A grating spectrometer with an unspecified bandpass was used to measure the absorption index of sapphire at T = 293 and 1773°K. Temperatures were measured to ± 1 deg. using an optical pyrometer. No error analysis was given. Data were digitized from lines.

These data were selected to construct the representative curve of Section I, Figure I - 1.2.

a. T = 293°K

λ	k	λ	k	λ	k
33.213	1.578E-01	29.726	1.085E-01	28.179	3.287E-03
27.017	2.465E-01	26.716	4.274E-01	26.380	1.423E+00
26.150	2.790E+00	26.011	1.345E+00	25.818	8.514E-01
25.503	5.062E-01	25.135	2.959E-01	24.724	9.862E-02
24.431	1.052E-01	23.979	2.498E-01	23.578	6.443E-01
23.283	1.114E+00	23.143	1.742E+00	23.003	3.083E+00
22.832	1.437E+01	22.651	1.087E+01	22.530	9.603E+00
22.296	7.574E+00	22.060	5.638E+00	21.832	4.372E+00
21.736	3.810E+00	21.527	3.189E+00	21.335	2.400E+00
21.092	1.492E+00	20.360	9.376E-01	20.610	3.517E-01
20.302	1.512E-01	19.902	4.274E-02	19.403	1.052E-01
18.352	3.057E-01	18.474	5.559E-01	18.162	8.810E-01
17.969	1.345E+00	17.306	2.032E+00	17.722	3.439E+00
17.652	5.586E+00	17.549	9.802E+00	17.443	1.251E+01
17.357	1.073E+01	17.274	9.451E+00	17.049	7.306E+00
16.845	5.869E+00	16.730	5.360E+00	16.413	4.408E+00
16.062	3.281E+00	15.908	2.919E+00	15.851	3.208E+00
15.772	4.247E+00	15.712	4.555E+00	15.612	4.408E+00
15.551	4.070E+00	15.451	3.734E+00	15.305	3.402E+00
15.168	3.182E+00	14.901	2.968E+00	14.630	2.712E+00
14.352	2.482E+00	14.068	2.235E+00	13.639	2.015E+00
13.292	1.795E+00	12.879	1.591E+00	12.510	1.407E+00
12.170	1.170E+00	11.869	9.665E-01	11.541	7.265E-01
11.186	4.701E-01	10.922	2.170E-01		

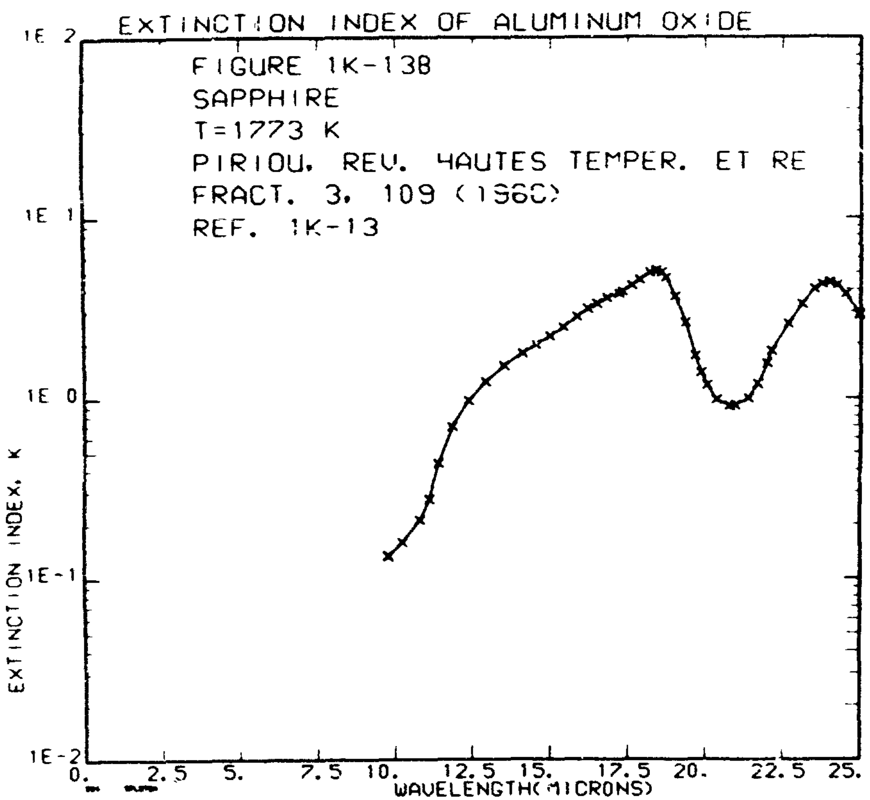

EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-13A
SAPPHIRE
T=293 K
PIRIOU. REV. HAUTES TEMPER. ET RE
FRACT. 3. 109 (1966)
REF. 1K-13
EXTINCTION INDEX, K
WAVELENGTH (MICRONS)
1E 2
1E 1
1E 0
1E-1
1E-2
1E-3
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

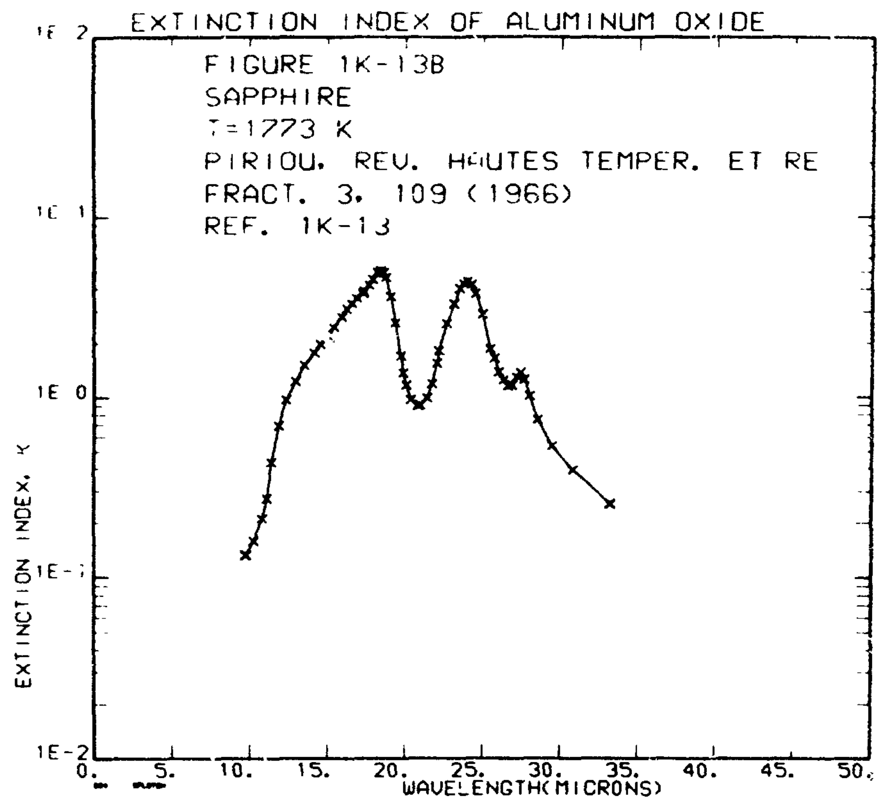

EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-13A
SAPPHIRE
T=293 K
PIRIOU. REV. HAUTES TEMPER. ET RE
FRACT. 3. 109 (1966)
REF. 1K-13
EXTINCTION INDEX, K
WAVELENGTH (MICRONS)
1E 2
1E 1
1E 0
1E-1
1E-2
1E-3
0.
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.

Piriou (Ref. 1K-13)

b. T = 1773°K

λ	k	λ	k	λ	k
.460	2.621E-07	.621	2.763E-07	.822	2.861E-07
1.042	2.877E-07	1.252	2.862E-07	1.560	2.872E-07
1.775	2.935E-07	2.073	3.118E-07	2.253	3.322E-07
2.348	3.444E-07	2.504	3.762E-07	2.736	4.558E-07
2.936	5.690E-07	3.123	7.488E-07	3.230	1.067E-06
3.435	1.626E-06	3.608	2.609E-06	3.783	4.251E-06
3.959	7.021E-06	4.171	1.212E-05	4.374	1.988E-05
4.594	3.039E-05	4.789	4.419E-05	4.956	6.104E-05
5.113	8.157E-05	9.791	1.320E-01	10.268	1.574E-01
10.804	2.114E-01	11.113	2.750E-01	11.403	4.324E-01
11.862	6.852E-01	12.391	9.650E-01	12.945	1.231E+00
13.540	1.512E+00	14.146	1.755E+00	14.557	1.965E+00
15.000	2.194E+00	15.442	2.456E+00	15.896	2.789E+00
16.231	3.076E+00	16.546	3.292E+00	16.867	3.537E+00
17.253	3.733E+00	17.360	3.848E+00	17.657	4.185E+00
17.916	4.522E+00	18.241	4.925E+00	18.428	5.036E+00
18.609	4.937E+00	18.751	4.610E+00	19.056	3.611E+00
19.393	2.591E+00	19.720	1.701E+00	19.879	1.375E+00
20.078	1.173E+00	20.374	9.793E-01	20.799	8.951E-01
20.977	9.094E-01	21.401	9.984E-01	21.712	1.196E+00
22.013	1.550E+00	22.169	1.811E+00	22.695	2.570E+00
23.145	3.304E+00	23.542	4.000E+00	23.794	4.258E+00
24.004	4.373E+00	24.249	4.227E+00	24.544	3.733E+00
24.958	2.906E+00	25.486	1.859E+00	25.719	1.645E+00
26.010	1.385E+00	26.334	1.250E+00	26.620	1.167E+00
26.850	1.178E+00	27.177	1.297E+00	27.427	1.372E+00
27.682	1.267E+00	28.003	1.025E+00	28.539	7.504E-01
29.446	5.390E-01	30.825	3.911E-01	33.210	2.560E-01


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-13B
SAPPHIRE
T=1773 K
PIRIOU. REV. HAUTES TEMPER. ET RE
FRACT. 3. 109 (1966)
REF. 1K-13
1E 2
1E 1
1E 0
1E-1
1E-2
EXTINCTION INDEX, K
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-13B
SAPPHIRE
T=1773 K
PIRIOU. REV. HAUTES TEMPER. ET RE
FRACT. 3. 109 (1966)
REF. 1K-13
1E 2
1E 1
1E 0
1E-2
EXTINCTION INDEX, K
0.
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.
WAVELENGTH(MICRONS)

Russell (Ref. 1K-15)

An asymmetric Fourier-transform method was used to measure k_o and k_e for sapphire. T = 300°K (unspecified room temperature). Total estimated probable error was 50 percent for $\alpha < 1\ cm^{-1}$, ±20 percent for $\alpha = 1.0\ cm^{-1}$ to $20.0\ cm^{-1}$, ±30 percent for $\alpha > 20.0\ cm^{-1}$. Data were taken from a table.

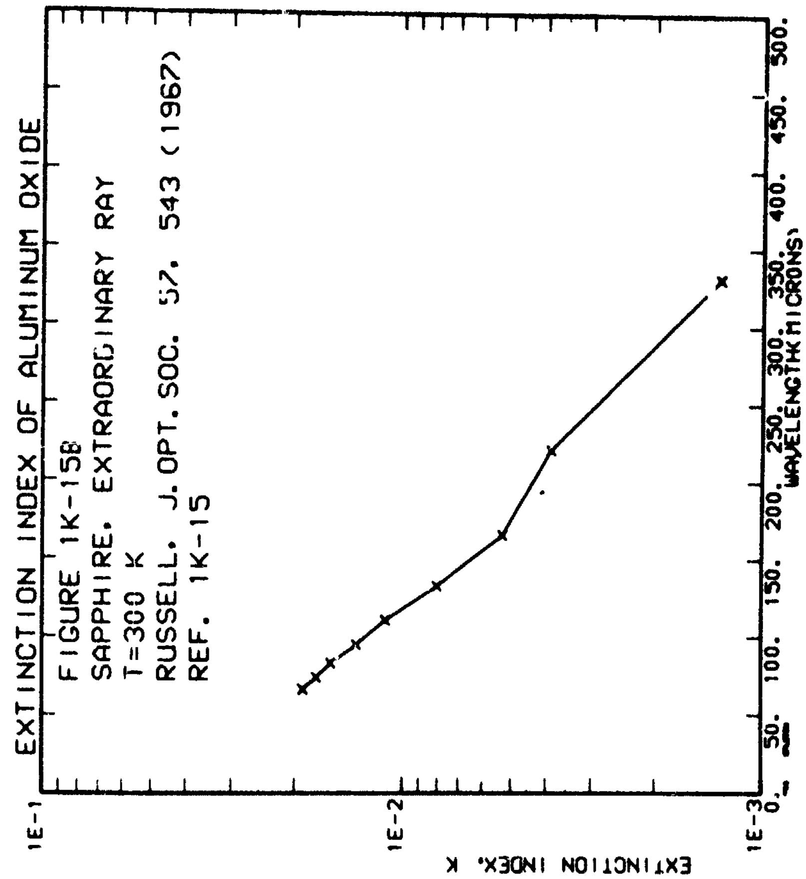
These data are in good agreement with the representative curve of Section I - 1.2.

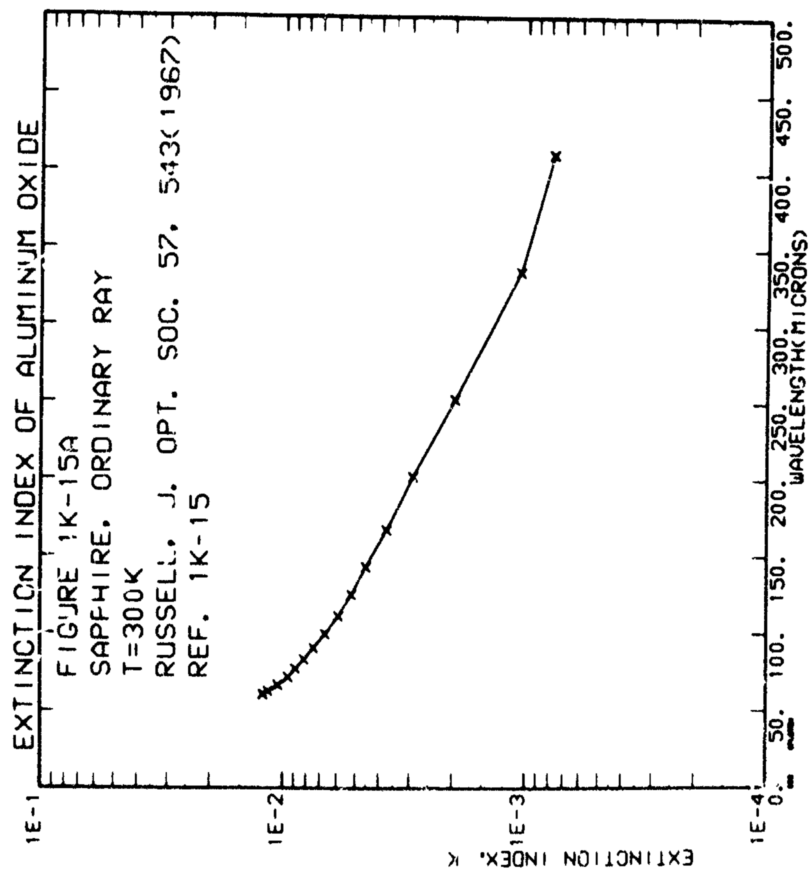
a. k_{ord}

λ	k	λ	k	λ	k
331.126	1.054E-03	220.264	2.980E-03	165.289	4.735E-03
132.275	5.158E-03	110.254	6.317E-03	94.518	7.446E-03
82.713	8.491E-03	73.475	9.180E-03	66.138	1.037E-02
60.132	1.254E-02				

b. k_{ext}

λ	k	λ	k	λ	k
331.126	1.318E-03	220.264	3.856E-03	165.289	5.261E-03
132.275	8.000E-03	110.254	1.114E-02	94.518	1.339E-02
32.713	1.330E-02	73.475	1.731E-02	66.138	1.889E-02


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-15B
SAPPHIRE. EXTRAORDINARY RAY
T=300 K
RUSSELL. J.OPT.SOC. 57. 543 (1967)
REF. 1K-15
EXTINCTION INDEX, K
1E-1
1E-2
1E-3
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.


EXTINCTION INDEX OF ALUMINUM OXIDE
FIGURE 1K-15A
SAPPHIRE. ORDINARY RAY
T=300K
RUSSELL. J. OPT. SOC. 57. 543(1967)
REF. 1K-15
EXTINCTION INDEX, K
1E-1
1E-2
1E-3
1E-4
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.

Streed (Ref. 1K-16)

The extinction index of alumina particles 1 μ in diameter and 99.5 percent pure and of 99.95 percent pure sapphire was measured using transmittance and reflectance measurements for the sapphire, and emittance measurements for the powders. A KBr prism spectrometer with a bandwidth of 0.016 μ to 0.15 μ used. No error analysis was given. The data were taken from tables. These data do not agree with the representative curve of Section I - 1.2.

a. Al_2O_3 Extinction Index
Sapphire, T = 300°K

λ(μ)	k
2.0	2.6×10^{-6}
2.5	4.5×10^{-6}
3.0	5.6×10^{-6}
3.5	1.23×10^{-5}
4.0	1.37×10^{-4}
5.0	0.0043
6.0	0.011
7.0	0.021
8.0	0.031
9.0	0.038
10.0	0.049
17.0	0.058
18.0	0.061
19.0	0.075
20.0	0.064
21.0	0.0618
22.0	0.06162

Streed (Ref. IK-16)

b. Al_2O_3 Extinction Index
Powder, T = 300°K

$\lambda(\mu)$	k	$\lambda(\mu)$	k
2.0	1.11×10^{-7}	10.5	2.034
2.5	5.0×10^{-7}	11.0	0.792
3.0	1.04×10^{-4}	12.0	0.179
3.5	6.1×10^{-5}	13.0	0.172
4.0	1.65×10^{-5}	14.0	0.199
5.0	3.26×10^{-5}	15.0	0.157
6.0	2.46×10^{-5}	16.0	0.168
7.0	0.015	17.0	0.067
8.0	0.391	18.0	0.098
9.0	4.055	19.0	0.199
10.0	5.87	20.0	0.612
		21.0	0.356
		22.0	0.103

Streed (Ref. 1K-16)

c. Flame Sprayed Powder, T = 300°K

λ (μ)	k
1.0	7.64×10^{-7}
1.5	1.60×10^{-6}
2.0	3.04×10^{-6}
2.5	6.27×10^{-6}
3.0	2.40×10^{-4}
3.5	5.10×10^{-5}
4.0	4.14×10^{-5}
4.5	6.22×10^{-5}
5.0	0.00012
5.5	0.00122
6.0	0.020
6.5	0.166
7.0	0.548
7.5	1.642
8.0	4.28
8.5	12.11
9.0	23.57
9.5	11.88
10.0	3.83
10.5	0.017
11.0	0.106
11.5	0.215
12.0	0.0196
13.0	0.0461
14.0	0.04
15.0	0.059
16.0	0.0471
17.0	0.0426
18.0	0.0398
19.0	0.0461
20.0	0.0662
21.0	0.0886
22.0	0.113

d. Flame Sprayed Powder, T = 1000°K

λ (μ)	k	λ (μ)	k
1.0	2.14×10^{-6}	17.5	0.02400
1.5	1.89×10^{-6}	18.0	0.02053
2.0	2.66×10^{-6}	18.5	0.02264
2.5	3.66×10^{-6}	19.0	0.02261
3.0	2.17×10^{-5}	19.5	0.03586
3.5	1.28×10^{-5}	20.0	0.01519
4.0	2.24×10^{-5}	20.5	0.04257
4.5	0.00012	21.0	0.04786
5.0	0.00056	21.5	0.03262
5.5	0.0034	22.0	0.03868
6.0	0.04127		
6.5	0.28554		
7.0	0.41254		
7.5	0.84663		
8.0	0.90307		
8.5	0.95951		
9.0	1.74334		
9.5	0.68399		
10.0	2.66349		
10.5	0.05261		
11.0	0.01221		
11.5	0.01053		
12.0	0.00865		
12.5	0.01177		
13.0	0.01660		
13.5	0.01990		
14.0	0.01788		
14.5	0.02666		
15.0	0.02413		
15.5	0.02187		
16.0	0.02043		
16.5	0.02503		
17.0	0.02023		

Streed (Ref. 1K-16)

e. Flame Sprayed, Powder, T = 1500°K

λ (μ)	k	λ (μ)	k
1.0	2.23×10^{-7}	16.5	0.00562
1.5	6.92×10^{-7}	17.0	0.00443
2.0	1.31×10^{-6}	17.5	0.00634
2.5	1.43×10^{-6}	18.0	0.00827
3.0	3.14×10^{-6}	18.5	0.02687
3.5	5.01×10^{-6}	19.0	0.04330
4.0	1.42×10^{-5}	19.5	0.11035
4.5	6.96×10^{-5}	20.0	0.14613
5.0	0.00053	20.5	0.11382
5.5	0.00302	21.0	0.12347
6.0	0.02125	21.5	0.08019
6.5	0.18710	22.0	0.02279
7.0	0.59809		
7.5	1.36920		
8.0	3.60427		
8.5	4.55257		
9.0	0.92292		
9.5	1.07239		
10.0	1.24704		
11.0	0.13552		
11.5	0.01877		
12.0	0.00544		
12.5	0.00459		
13.0	0.00279		
13.5	0.00620		
14.0	0.00533		
14.5	0.00588		
15.0	0.00436		
15.5	0.00450		
16.0	0.00343		

f. Flame Sprayed Powder, T = 2000°K

λ (μ)	k	λ (μ)	k
1.0	3.03×10^{-7}	16.5	0.00576
1.5	8.49×10^{-7}	17.0	0.00558
2.0	1.05×10^{-6}	17.5	0.00627
2.5	1.82×10^{-6}	18.0	0.00712
3.0	1.44×10^{-6}	18.5	0.01111
3.5	4.32×10^{-6}	19.0	0.02261
4.0	1.27×10^{-5}	19.5	0.02752
4.5	1.03×10^{-4}	20.0	0.06619
5.0	0.02435	20.5	0.05749
5.5	0.01042	21.0	0.05262
6.0	0.10709	21.5	0.05056
6.5	1.18664	22.0	0.02932
7.0	1.74375		
7.5	3.11248		
8.0	4.69408		
8.5	7.46471		
9.0	0.88074		
9.5	0.77691		
10.0	1.31256		
11.0	0.23054		
11.5	0.03387		
12.0	0.01243		
12.5	0.00686		
13.0	0.00678		
13.5	0.00760		
14.0	0.00739		
14.5	0.00710		
15.0	0.00681		
15.5	0.0003		
16.0	0.00437		

III-1.3 Tabulated Spectral Emissivity Data — Aluminum Oxide

Contents

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Aronson (Ref. 1SE-2)

Microgrit "WCA" alumina precision lapping powders, 99 percent pure α-Al_2O_3, were studied. Particles have a platelet configuration with a diameter 5x the thickness. Particle size distributions are shown in Figure III-1.3.1, the average diameter in microns being approximately the WCA number. The sample temperature was determined by taking $\epsilon(\lambda) = 1$ at 1035 cm^{-1}, a Christiansen frequency. An interferometer with 15 cm^{-1} resolution was used with a standard blackbody and dry-ice cooled chamber. Sample surface temperatures were calculated to be 298°K, with the sample heating done by conduction from a tray held at 340.4 ±0.6°K. These data are not corrected for atmospheric absorption effects, and there is an apparent emittance peak at 660 cm^{-1} (15.2μ) due to CO_2, and peaks at the high frequency end and 575 cm^{-1} (17.4 μ) due to H_2O. No error analysis was given. Data are digitized from lines.

The 10 WCA, 300°K curve was taken to be representative (Figure I-1.3.2).

a. WCA = 5

λ	ε	λ	ε	λ	ε
22.286	8.646E-01	21.867	8.559E-01	21.598	8.727E-01
21.297	8.974E-01	21.091	9.087E-01	20.928	9.103E-01
20.668	8.990E-01	20.530	8.963E-01	20.292	8.967E-01
20.170	8.876E-01	19.937	8.809E-01	19.776	8.701E-01
19.627	8.522E-01	19.383	8.376E-01	19.151	8.392E-01
18.878	8.515E-01	18.702	8.623E-01	18.556	8.610E-01
18.394	8.795E-01	18.275	8.913E-01	18.135	8.939E-01
17.980	8.899E-01	17.827	8.664E-01	17.711	8.531E-01
17.631	8.500E-01	17.503	6.557E-01	17.372	8.582E-01
17.241	8.515E-01	17.096	8.339E-01	16.998	8.112E-01
16.896	8.036E-01	16.[illegible]	8.099E-01	16.648	8.443E-01
16.497	8.587E-01	16.[illegible]	8.834E-01	16.165	8.976E-01
16.002	9.093E-01	15.[illegible]	9.143E-01	15.846	9.064E-01
15.749	8.917E-01	15.[illegible]	8.819E-01	15.613	8.772E-01
15.512	8.898E-01	15.4[illegible]	9.072E-01	15.322	9.433E-01
15.270	9.542E-01	15.189	9.483E-01	15.076	9.270E-01
14.972	9.031E-01	14.897	8.986E-01	14.765	9.066E-01
14.612	9.025E-01	14.561	8.894E-01	14.455	8.844E-01
14.372	8.822E-01	14.311	8.913E-01	14.211	9.014E-01
14.117	9.071E-01	14.020	8.964E-01	13.934	8.837E-01

Aronson (Ref. 1SE-2)

a. WCA = 5 (continued)

λ	ε	λ	ε	λ	ε
13.967	8.819E-01	13.795	8.919E-01	13.751	8.949E-01
13.708	9.018E-01	13.639	9.001E-01	13.560	8.960E-01
13.437	8.957E-01	13.349	8.970E-01	13.249	8.986E-01
13.130	8.977E-01	13.047	8.927E-01	12.964	9.012E-01
12.855	9.053E-01	12.775	9.132E-01	12.711	9.042E-01
12.617	8.995E-01	12.521	8.948E-01	12.452	9.030E-01
12.371	9.049E-01	12.307	8.973E-01	12.224	8.944E-01
12.184	8.958E-01	12.144	8.907E-01	12.084	8.984E-01
11.959	8.908E-01	11.889	8.793E-01	11.823	8.742E-01
11.765	8.705E-01	11.699	8.733E-01	11.621	8.654E-01
11.594	8.562E-01	11.524	8.600E-01	11.477	8.535E-01
11.425	8.551E-01	11.355	8.630E-01	11.254	8.655E-01
11.228	8.717E-01	11.151	8.686E-01	11.113	8.768E-01
11.056	8.825E-01	11.020	8.785E-01	10.952	8.926E-01
10.914	8.967E-01	10.899	9.040E-01	10.841	9.077E-01
10.801	9.115E-01	10.728	9.132E-01	10.689	9.211E-01
10.560	9.321E-01	10.613	9.399E-01	10.526	9.428E-01
10.441	9.429E-01	10.455	9.486E-01	10.399	9.519E-01
10.343	9.545E-01	10.313	9.639E-01	10.246	9.665E-01
10.199	9.547E-01	10.131	9.709E-01	10.089	9.792E-01
10.029	9.792E-01	9.982	9.839E-01	9.950	9.759E-01
9.876	9.750E-01	9.917	9.741E-01	9.750	9.725E-01
9.711	9.763E-01	9.644	9.738E-01	9.568	9.732E-01
9.479	9.735E-01	9.443	9.763E-01	9.403	9.721E-01
9.341	9.745E-01	9.274	9.773E-01	9.189	9.740E-01
9.116	9.682E-01	9.045	9.709E-01	8.970	9.693E-01
8.924	9.659E-01	8.887	9.606E-01	8.840	9.593E-01
8.823	9.551E-01	8.736	9.533E-01	8.662	9.464E-01
8.625	9.342E-01	8.611	9.241E-01	8.583	9.203E-01
8.564	9.251E-01	8.540	9.277E-01	8.512	9.349E-01
8.471	9.356E-01	8.449	9.369E-01	8.420	9.263E-01
8.401	9.205E-01	8.333	9.191E-01	8.313	9.121E-01
8.294	9.046E-01	8.252	8.986E-01	8.213	8.984E-01
8.197	8.948E-01	8.187	8.998E-01	8.156	8.960E-01
8.136	8.825E-01	8.118	8.686E-01	8.079	8.671E-01
8.062	8.755E-01	8.000	8.793E-01	7.983	8.739E-01
7.959	8.708E-01	7.969	8.601E-01	7.944	8.597E-01
7.929	8.620E-01				

Aronson (Ref. 1SE-2)

b. WCA = 9

λ	ε	λ	ε	λ	ε
7.330	7.441E-01	7.371	7.676E-01	7.398	7.451E-01
7.438	7.304E-01	7.482	7.587E-01	7.549	7.856E-01
7.633	7.817E-01	7.672	7.841E-01	7.705	7.913E-01
7.727	7.861E-01	7.756	7.876E-01	7.778	7.911E-01
7.825	7.859E-01	7.831	7.896E-01	7.856	7.983E-01
7.881	8.106E-01	7.914	8.081E-01	7.981	8.042E-01
8.014	8.153E-01	8.042	8.239E-01	8.068	8.326E-01
8.097	8.329E-01	8.116	8.291E-01	8.172	8.291E-01
8.201	8.395E-01	8.233	8.425E-01	8.261	8.387E-01
8.230	8.437E-01	8.315	8.640E-01	8.341	8.793E-01
8.369	8.839E-01	8.394	8.887E-01	8.437	8.869E-01
8.489	8.855E-01	8.516	8.941E-01	8.577	8.956E-01
8.694	8.968E-01	8.634	9.081E-01	8.672	9.182E-01
8.796	9.348E-01	8.775	9.357E-01	8.834	9.503E-01
8.998	9.641E-01	8.979	9.620E-01	9.043	9.715E-01
9.117	9.847E-01	9.201	9.796E-01	9.265	9.912E-01
9.421	9.964E-01	9.636	9.960E-01	9.919	9.959E-01
10.059	9.921E-01	10.203	9.867E-01	10.354	9.604E-01
10.454	9.492E-01	10.502	9.368E-01	10.590	9.321E-01
10.665	9.123E-01	10.709	9.115E-01	10.728	9.007E-01
10.737	8.975E-01	10.819	8.891E-01	10.877	8.891E-01
10.920	8.745E-01	10.965	8.696E-01	11.039	8.610E-01
11.114	8.541E-01	11.179	8.550E-01	11.226	8.570E-01
11.278	8.501E-01	11.359	8.437E-01	11.456	8.418E-01
11.479	8.339E-01	11.546	8.353E-01	11.625	8.353E-01
11.589	8.402E-01	11.737	8.408E-01	11.777	8.503E-01
11.882	8.573E-01	11.950	8.625E-01	12.012	8.739E-01
12.123	8.745E-01	12.169	8.822E-01	12.235	8.855E-01
12.303	8.904E-01	12.433	8.903E-01	12.497	8.847E-01
12.565	8.892E-01	12.664	8.879E-01	12.710	8.852E-01
12.785	8.896E-01	12.874	8.820E-01	12.979	8.817E-01
13.091	8.915E-01	13.184	8.849E-01	13.302	8.839E-01
13.528	8.729E-01	13.657	8.763E-01	13.725	8.771E-01
13.730	8.724E-01	13.904	8.647E-01	14.084	8.652E-01
14.133	8.674E-01	14.374	8.531E-01	14.561	8.575E-01
14.596	8.590E-01	14.683	8.634E-01	14.842	8.615E-01
14.994	8.624E-01	15.122	8.884E-01	15.235	8.971E-01
15.373	8.755E-01	15.452	8.531E-01	15.558	8.336E-01
15.653	8.304E-01	15.737	8.415E-01	15.774	8.580E-01
15.892	8.719E-01	15.964	8.322E-01	16.070	8.783E-01
16.135	8.689E-01	16.394	8.497E-01	16.584	8.059E-01
16.369	7.681E-01	16.801	7.374E-01	16.950	7.336E-01

b. WCA = 9 (continued)

λ	ε	λ	ε	λ	ε
17.010	7.512E-01	17.018	7.597E-01	17.220	8.059E-01
17.329	8.198E-01	17.432	8.218E-01	17.584	8.202E-01
17.709	8.328E-01	17.733	8.425E-01	17.852	8.524E-01
17.900	8.713E-01	18.026	8.783E-01	18.123	8.899E-01
18.232	8.960E-01	18.426	8.936E-01	18.599	8.886E-01
18.436	8.711E-01	18.990	8.684E-01	19.108	8.630E-01
19.355	8.534E-01	19.624	8.713E-01	19.896	8.681E-01
20.119	8.560E-01	20.320	8.382E-01	20.474	8.365E-01
20.241	8.681E-01	20.492	8.751E-01	20.709	8.896E-01
21.016	9.081E-01	21.255	8.955E-01	21.443	8.758E-01
21.634	8.351E-01	22.203	8.247E-01	22.525	8.076E-01
22.640	7.955E-01	23.056	8.003E-01	23.272	8.163E-01
23.446	8.444E-01	23.759	8.556E-01	24.018	8.756E-01
24.356	8.737E-01	24.756	8.681E-01	24.963	8.469E-01
25.270	8.281E-01	25.051	8.422E-01		

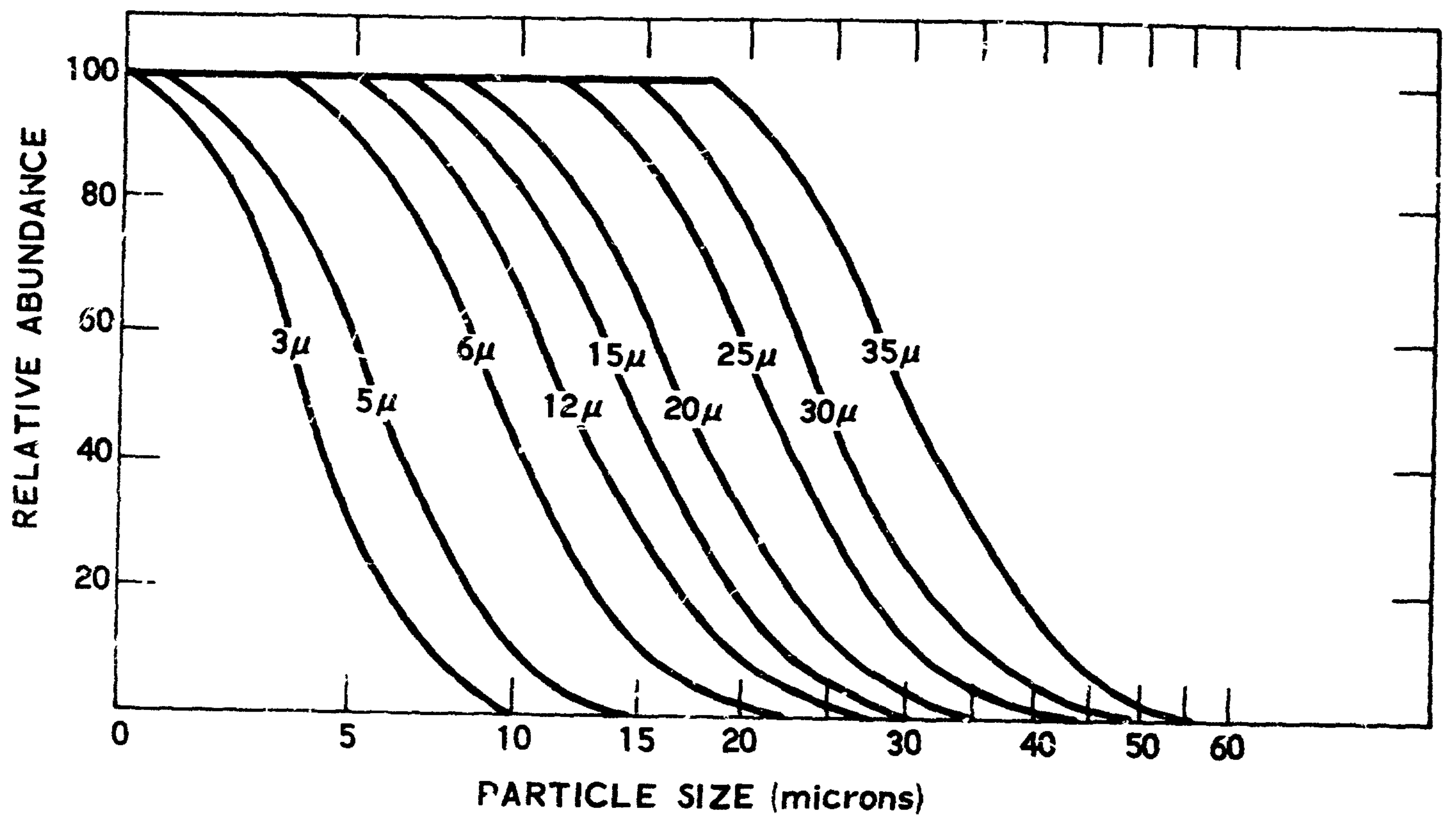
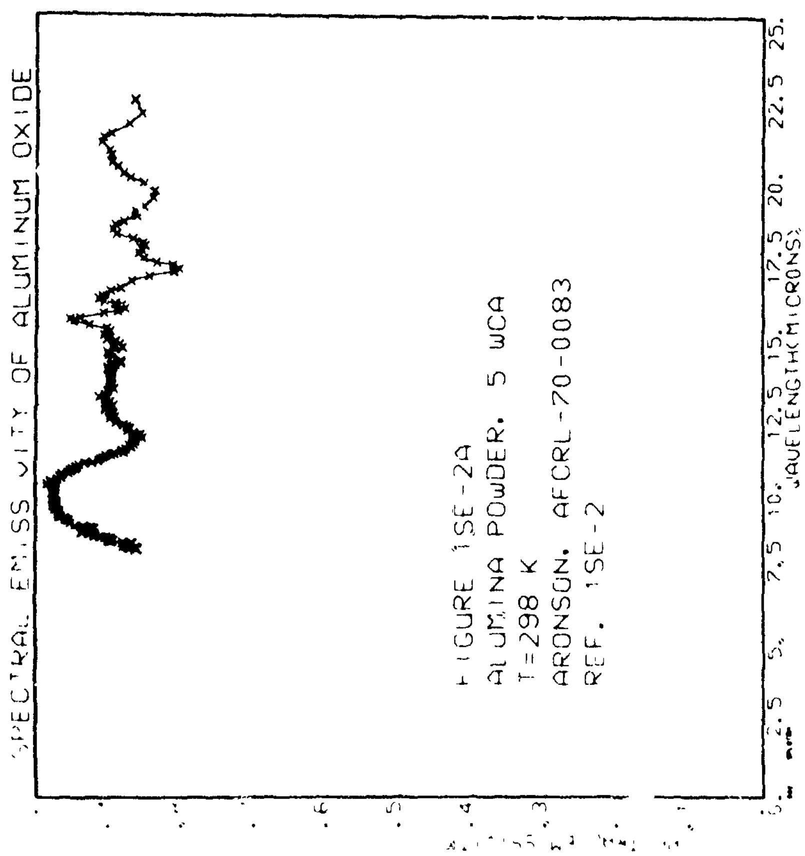
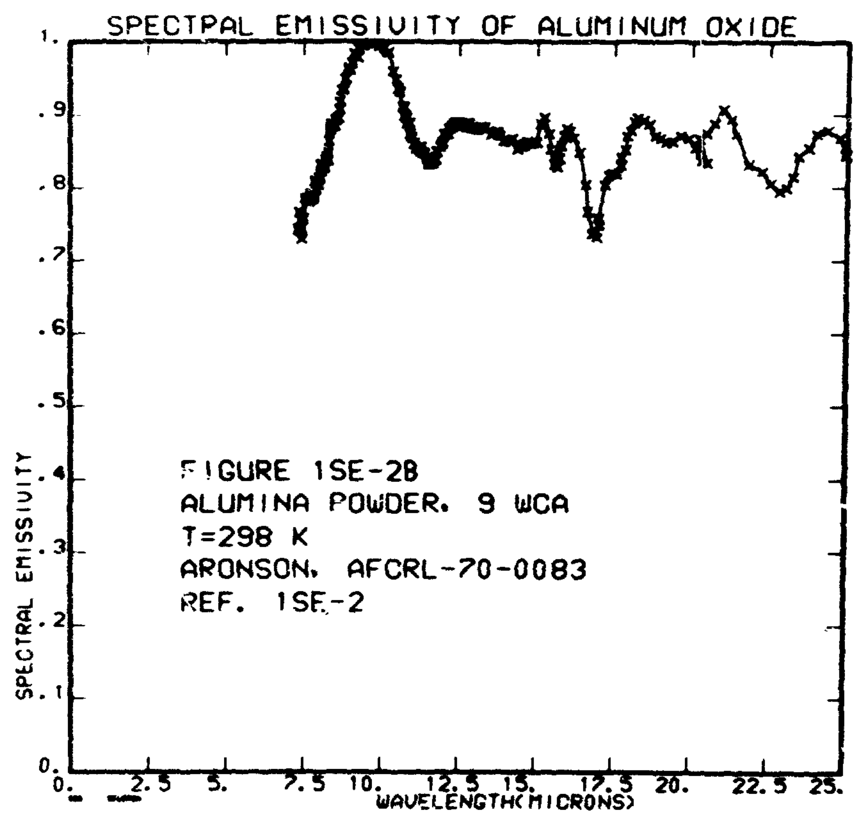
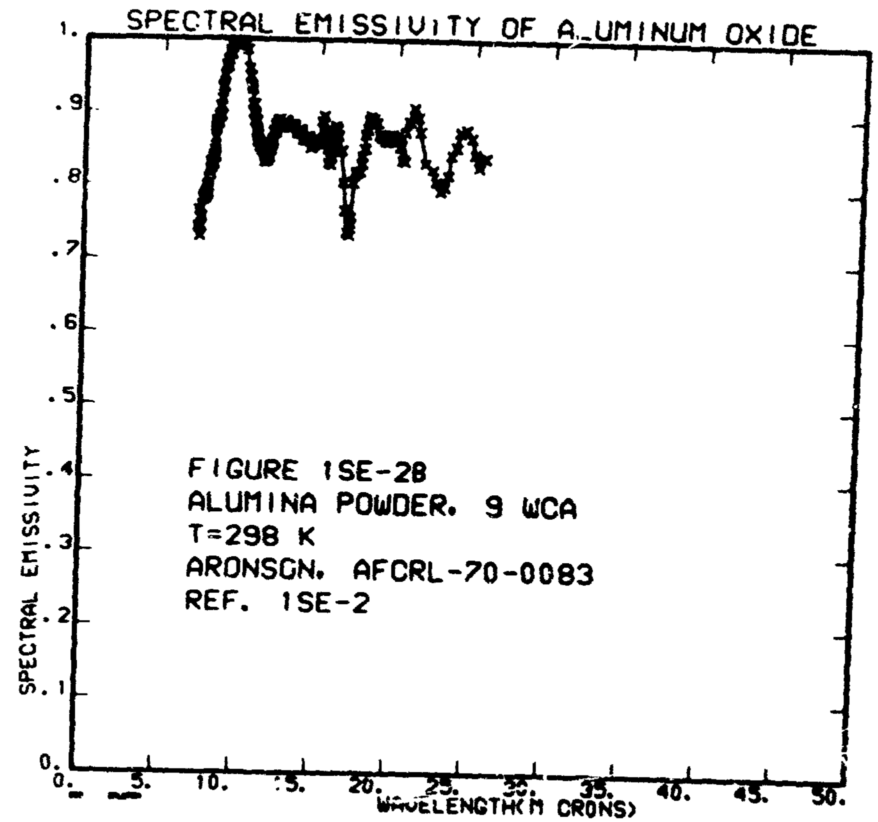


Figure III-1.3.1: Particle Size Distribution for WC' Alumina Lapping Powders


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-2A
ALUMINA POWDER. 5 WCA
T=298 K
ARONSON. AFCRL-70-0083
REF. 1SE-2
2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
WAVELENGTH(MICRONS)



SPECTPAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-28
ALUMINA POWDER, 9 WCA
T=298 K
ARONSON, AFCRL-70-0083
REF. 1SE-2
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-28
ALUMINA POWDER, 9 WCA
T=298 K
ARONSON, AFCRL-70-0083
REF. 1SE-2
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)

Aronson (Ref. 1SE-2)

c. WCA = 15

λ	ε	λ	ε	λ	ε
24.953	8.742E-01	24.508	8.724E-01	23.379	8.068E-01
23.717	9.030E-01	23.334	8.174E-01	23.334	8.082E-01
23.122	7.573E-01	22.655	7.511E-01	22.662	7.523E-01
22.417	7.575E-01	22.276	7.715E-01	21.913	7.787E-01
21.659	8.671E-01	21.431	8.506E-01	21.400	8.752E-01
21.105	9.073E-01	20.940	8.178E-01	20.505	8.653E-01
20.345	8.345E-01	20.042	8.307E-01	19.817	8.814E-01
19.[illegible]8	8.740E-01	19.363	8.781E-01	19.006	8.998E-01
18.355	5.980E-01	18.333	8.317E-01	18.144	8.789E-01
17.986	8.556E-01	17.940	8.437E-01	17.723	8.068E-01
17.5[illegible]	7.910E-01	17.493	7.742E-01	17.154	7.213E-01
17.127	7.151E-01	16.856	6.882E-01	16.888	6.848E-01
16.730	6.921E-01	16.667	7.181E-01	16.381	7.998E-01
16.365	8.145E-01	16.130	8.502E-01	16.111	8.535E-01
15.997	8.401E-01	15.833	8.222E-01	15.818	8.113E-01
15.737	8.300E-01	15.697	7.841E-01	15.563	7.794E-01
15.417	8.113E-01	15.286	8.457E-01	15.213	8.512E-01
15.137	8.405E-01	14.933	8.193E-01	14.772	8.133E-01
14.996	8.201E-01	14.582	8.116E-01	14.404	8.039E-01
14.747	8.020E-01	14.243	8.152E-01	14.146	8.237E-01
14.336	8.224E-01	13.950	8.230E-01	13.890	8.204E-01
13.[illegible]	8.257E-01	13.716	8.233E-01	13.595	8.266E-01
13.516	8.240E-01	13.440	8.296E-01	13.413	8.352E-01
13.288	8.464E-01	13.214	8.415E-01	13.177	8.435E-01
13.133	8.373E-01	13.050	8.375E-01	12.902	8.427E-01
12.858	8.430E-01	12.796	8.506E-01	12.690	8.530E-01
12.623	8.556E-01	12.512	8.526E-01	12.408	8.521E-01
12.432	8.548E-01	12.309	8.514E-01	12.290	8.550E-01
12.214	8.515E-01	11.975	8.218E-01	11.910	8.082E-01
11.816	8.014E-01	11.709	7.884E-01	11.629	7.814E-01
11.595	7.767E-01	11.461	7.951E-01	11.394	8.092E-01
11.312	8.144E-01	11.252	8.154E-01	11.220	8.204E-01
11.122	8.137E-01	11.070	8.279E-01	10.962	8.420E-01
10.92[illegible]	8.489E-01	10.814	8.601E-01	10.776	8.727E-01
10.703	8.776E-01	10.578	8.894E-01	10.629	8.962E-01
10.572	9.128E-01	10.502	9.241E-01	10.353	9.537E-01
10.307	9.603E-01	10.262	9.746E-01	10.182	9.868E-01
10.945	9.392E-01	9.909	1.008E+00	9.770	1.010E 00

c. WCA = 15 (continued)

λ	ε	λ	ε	λ	ε
9.524	1.010E+00	9.531	1.009E+00	9.448	1.003E+00
9.346	9.991E-01	9.249	9.905E-01	9.210	9.832E-01
9.148	9.748E-01	9.100	9.735E-01	9.060	9.760E-01
9.019	9.695E-01	9.004	9.600E-01	8.977	9.583E-01
8.949	9.523E-01	8.918	9.545E-01	8.870	9.460E-01
8.823	9.422E-01	8.764	9.329E-01	8.704	9.276E-01
8.647	9.150E-01	8.594	8.953E-01	8.538	8.906E-01
8.495	8.911E-01	8.483	8.844E-01	8.363	8.718E-01
8.345	8.588E-01	8.302	8.412E-01	8.270	8.347E-01
8.232	8.282E-01	8.210	8.213E-01	8.156	8.215E-01
8.155	8.156E-01	8.064	8.156E-01	8.036	8.118E-01
8.009	8.083E-01				

Aronson (Ref. 1SE-2)

d. WCA = 20

λ	ε	λ	ε	λ	ε
7.332	7.366E-01	7.370	7.574E-01	7.426	7.529E-01
7.454	7.431E-01	7.490	7.621E-01	7.526	7.768E-01
7.576	7.614E-01	7.670	7.836E-01	7.701	7.867E-01
7.731	7.813E-01	7.810	7.985E-01	7.834	8.096E-01
7.930	8.003E-01	7.980	8.072E-01	8.024	8.187E-01
8.085	8.229E-01	8.139	8.297E-01	8.189	8.282E-01
8.212	8.430E-01	8.262	8.412E-01	8.313	8.612E-01
8.372	8.728E-01	8.426	8.810E-01	8.480	8.896E-01
8.531	8.948E-01	8.592	8.950E-01	8.626	9.103E-01
8.707	9.177E-01	8.778	9.236E-01	8.833	9.355E-01
8.886	9.411E-01	8.935	9.528E-01	9.020	9.643E-01
9.121	9.793E-01	9.220	9.780E-01	9.298	9.926E-01
9.531	9.924E-01	9.802	9.980E-01	10.068	9.903E-01
10.296	9.593E-01	10.390	9.337E-01	10.423	9.231E-01
10.595	9.070E-01	10.615	8.864E-01	10.694	8.659E-01
10.780	8.462E-01	10.883	8.334E-01	10.980	8.104E-01
11.028	8.008E-01	11.104	7.948E-01	11.153	7.864E-01
11.239	7.789E-01	11.366	7.790E-01	11.448	7.661E-01
11.492	7.466E-01	11.559	7.421E-01	11.604	7.309E-01
11.734	7.379E-01	11.870	7.555E-01	11.976	7.732E-01
12.049	7.795E-01	12.115	7.919E-01	12.173	7.933E-01

Aronson (Ref. 1SE-2)

d. WCA = 20 (continued)

λ	ε	λ	ε	λ	ε
12.237	8.069E-01	12.344	8.173E-01	12.462	8.109E-01
12.561	8.133E-01	12.706	8.111E-01	12.785	8.121E-01
12.892	8.037E-01	13.041	8.024E-01	13.065	7.950E-01
13.181	8.005E-01	13.311	8.035E-01	13.430	7.931E-01
13.593	7.829E-01	13.803	7.319E-01	13.857	7.723E-01
13.930	7.640E-01	14.103	7.705E-01	14.175	7.718E-01
14.354	7.483E-01	14.496	7.456E-01	14.594	7.512E-01
14.728	7.547E-01	14.831	7.441E-01	14.994	7.430E-01
15.082	7.512E-01	15.202	7.703E-01	15.299	7.730E-01
15.399	7.523E-01	15.533	7.086E-01	15.636	7.022E-01
15.698	7.146E-01	15.784	7.413E-01	15.882	7.735E-01
15.992	7.316E-01	16.096	8.097E-01	16.255	7.872E-01
16.397	7.423E-01	16.477	7.059E-01	16.573	6.837E-01
16.649	6.573E-01	16.828	6.392E-01	17.015	6.512E-01
17.171	6.819E-01	17.285	7.087E-01	17.437	7.344E-01
17.611	7.695E-01	17.731	7.748E-01	17.883	8.000E-01
18.023	8.331E-01	18.264	8.696E-01	18.575	8.788E-01
18.987	8.776E-01	19.297	8.945E-01	19.725	8.634E-01
19.917	8.711E-01	20.128	8.729E-01	20.334	8.575E-01
20.612	8.511E-01	20.736	8.696E-01	21.033	8.810E-01
21.259	8.657E-01	21.351	8.407E-01	21.431	8.118E-01
21.578	7.970E-01	21.616	7.619E-01	21.696	7.369E-01
21.824	7.171E-01	22.021	7.839E-01	22.419	7.034E-01
22.537	6.929E-01	22.683	6.935E-01	22.901	7.081E-01
23.038	7.369E-01	23.191	7.587E-01	23.304	7.908E-01
23.579	8.183E-01	23.907	8.323E-01	24.557	8.418E-01
24.942	8.413E-01	25.042	8.336E-01	25.362	8.316E-01
25.518	8.424E-01				

Aronson (Ref. 1SE-2)

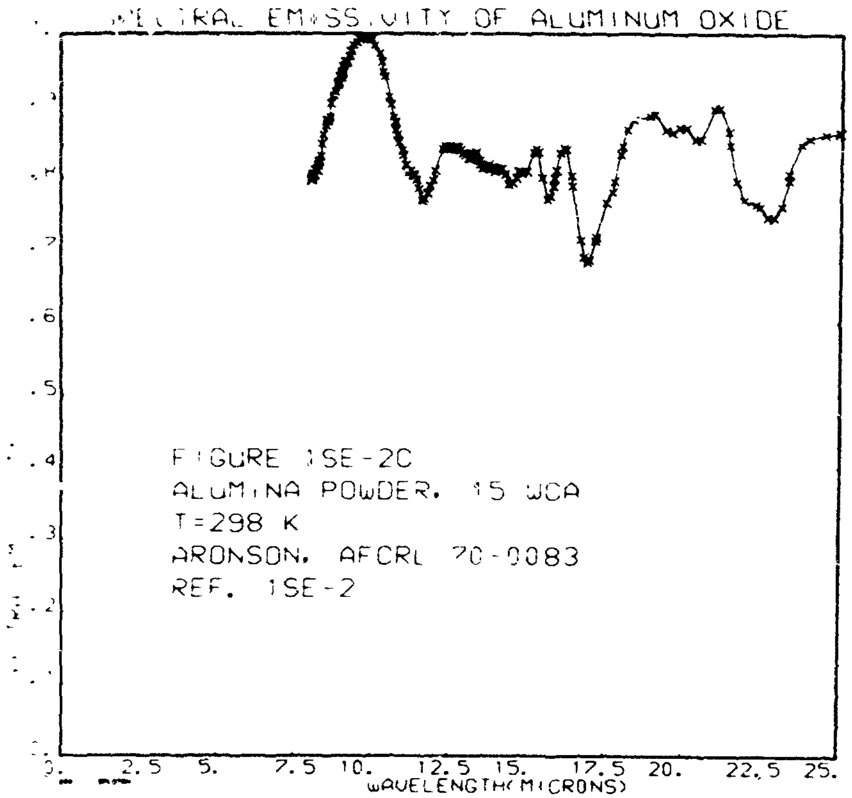
e. WCA = 30

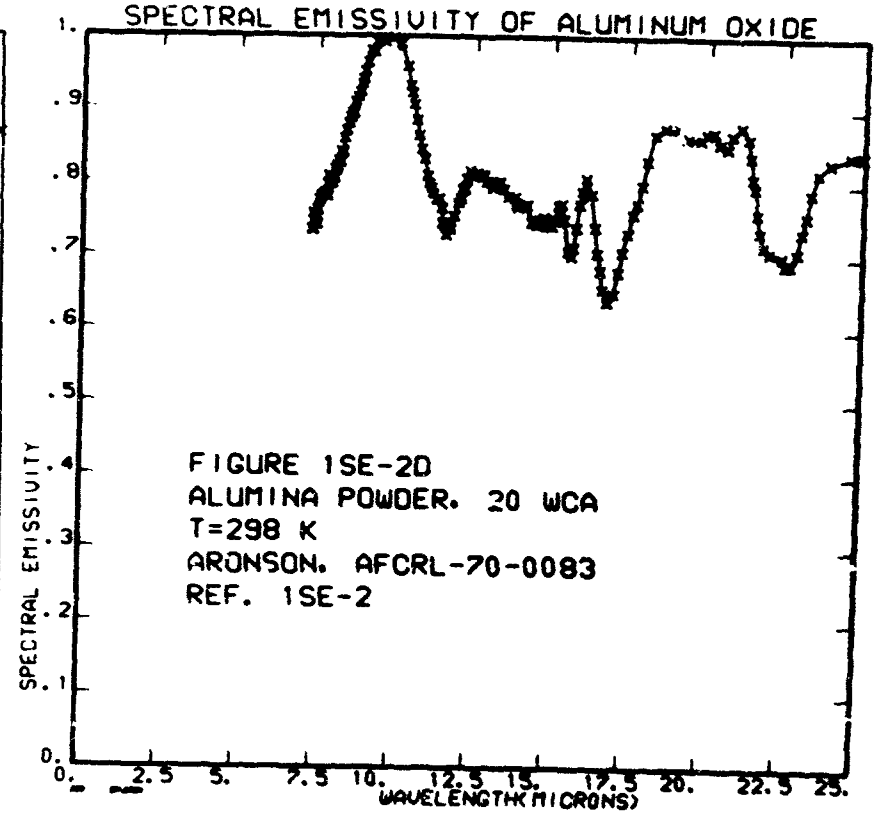
λ	ε	λ	ε	λ	ε
22.294	6.290E-01	22.143	6.407E-01	21.762	6.523E-01
21.487	7.315E-01	21.340	7.805E-01	21.156	8.254E-01
21.159	8.557E-01	20.956	8.749E-01	20.727	8.682E-01
20.607	8.460E-01	20.357	8.385E-01	20.202	8.392E-01
19.956	8.656E-01	19.793	8.805E-01	19.660	8.840E-01
19.476	8.790E-01	19.247	8.786E-01	18.985	8.817E-01

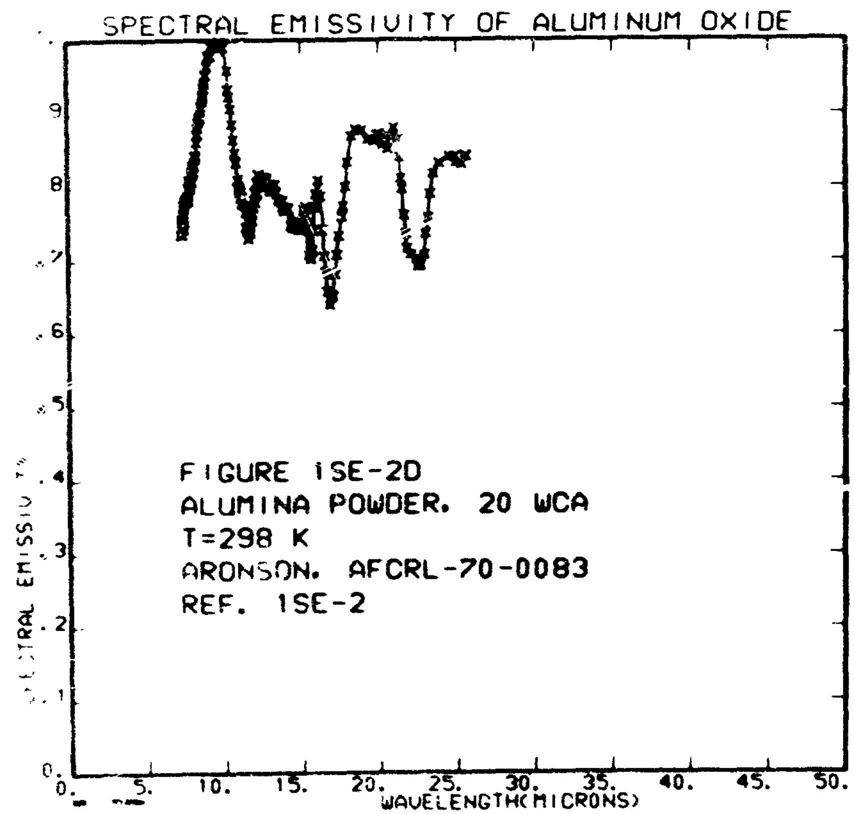
Aronson (Ref. 1SE-2)

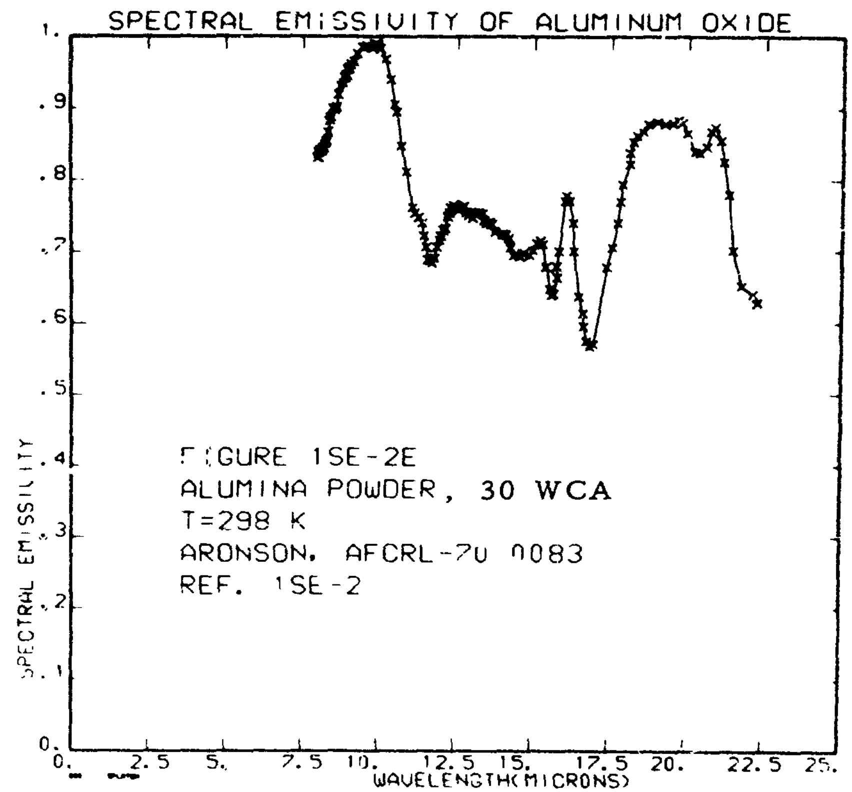
e. WCA = 30 (continued)

λ	ε	λ	ε	λ	ε
18.589	8.783E-01	18.523	8.672E-01	18.347	8.625E-01
18.223	8.536E-01	18.111	8.380E-01	18.099	8.225E-01
17.896	7.941E-01	17.806	7.707E-01	17.725	7.402E-01
17.571	7.052E-01	17.377	6.781E-01	16.948	5.734E-01
16.839	5.670E-01	16.743	5.746E-01	16.641	5.954E-01
16.612	6.130E-01	16.481	6.377E-01	16.320	7.031E-01
16.285	7.439E-01	16.155	7.717E-01	16.069	7.785E-01
16.006	7.716E-01	15.837	7.007E-01	15.769	6.794E-01
15.752	6.643E-01	15.649	6.417E-01	15.593	6.395E-01
15.534	6.470E-01	15.411	6.787E-01	15.284	7.102E-01
15.271	7.157E-01	15.135	7.116E-01	14.993	7.010E-01
14.951	6.943E-01	14.659	6.973E-01	14.527	6.937E-01
14.446	6.970E-01	14.351	6.945E-01	14.238	7.058E-01
14.188	7.198E-01	14.086	7.242E-01	13.988	7.239E-01
13.893	7.231E-01	13.736	7.287E-01	13.637	7.393E-01
13.572	7.419E-01	13.471	7.405E-01	13.380	7.443E-01
13.323	7.542E-01	13.201	7.555E-01	13.117	7.530E-01
13.006	7.477E-01	12.897	7.517E-01	12.799	7.558E-01
12.739	7.540E-01	12.640	7.617E-01	12.567	7.590E-01
12.462	7.614E-01	12.380	7.658E-01	12.292	7.627E-01
12.265	7.556E-01	12.198	7.497E-01	12.126	7.334E-01
12.063	7.301E-01	11.994	7.228E-01	11.939	7.163E-01
11.870	7.069E-01	11.790	6.905E-01	11.701	6.837E-01
11.624	6.878E-01	11.562	6.884E-01	11.506	7.067E-01
11.437	7.220E-01	11.374	7.400E-01	11.262	7.487E-01
11.128	7.546E-01	11.069	7.626E-01	10.860	8.116E-01
10.686	8.479E-01	10.537	8.958E-01	10.466	9.069E-01
10.336	9.438E-01	10.157	9.688E-01	9.992	9.829E-01
9.835	9.898E-01	9.802	9.889E-01	9.724	9.844E-01
9.544	9.878E-01	9.403	9.854E-01	9.237	9.767E-01
9.133	9.558E-01	9.035	9.611E-01	8.964	9.559E-01
8.945	9.546E-01	8.902	9.466E-01	8.845	9.430E-01
8.811	9.349E-01	8.714	9.318E-01	8.639	9.189E-01
8.593	9.029E-01	8.538	8.987E-01	8.452	9.007E-01
8.392	8.880E-01	8.356	8.836E-01	8.309	8.678E-01
8.248	8.548E-01	8.214	8.535E-01	8.194	8.445E-01
8.151	8.439E-01	8.103	8.402E-01	8.053	8.414E-01
8.017	8.386E-01	7.994	8.311E-01		


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-2C
ALUMINA POWDER, 15 WCA
T=298 K
ARONSON, AFCRL 70-0083
REF. 1SE-2
.6
.5
.4
.3
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-2D
ALUMINA POWDER, 20 WCA
T=298 K
ARONSON, AFCRL-70-0083
REF. 1SE-2
SPECTRAL EMISSIVITY
1.
.9
.8
.7
.6
.5
.4
.3
.2
.1
0.
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-2D
ALUMINA POWDER. 20 WCA
T=298 K
ARONSON. AFCRL-70-0083
REF. 1SE-2
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
.1 .2 .3 .4 .5 .6 .7 .8 .9


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-2E
ALUMINA POWDER, 30 WCA
T=298 K
ARONSON. AFCRL-70 0083
REF. 1SE-2
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
.1 .2 .3 .4 .5 .6 .7 .8 .9 1.

Bergquam (Ref. 1SE-3)

Layers of 0.3μ diameter Linde Type A alumina powder with a thickness of 0.2, 0.100, and 0.125 inches on a platinum substrate were studied with no particle compaction (7 percent solid), light compaction (14 percent solid) and heavy compaction (24.5 percent solid) using a conventional monochromator and detector system. Samples were heated to approximately 1000°K, and measured with a thermocouple near the surface. No error analysis was given. Digitized from discrete points.

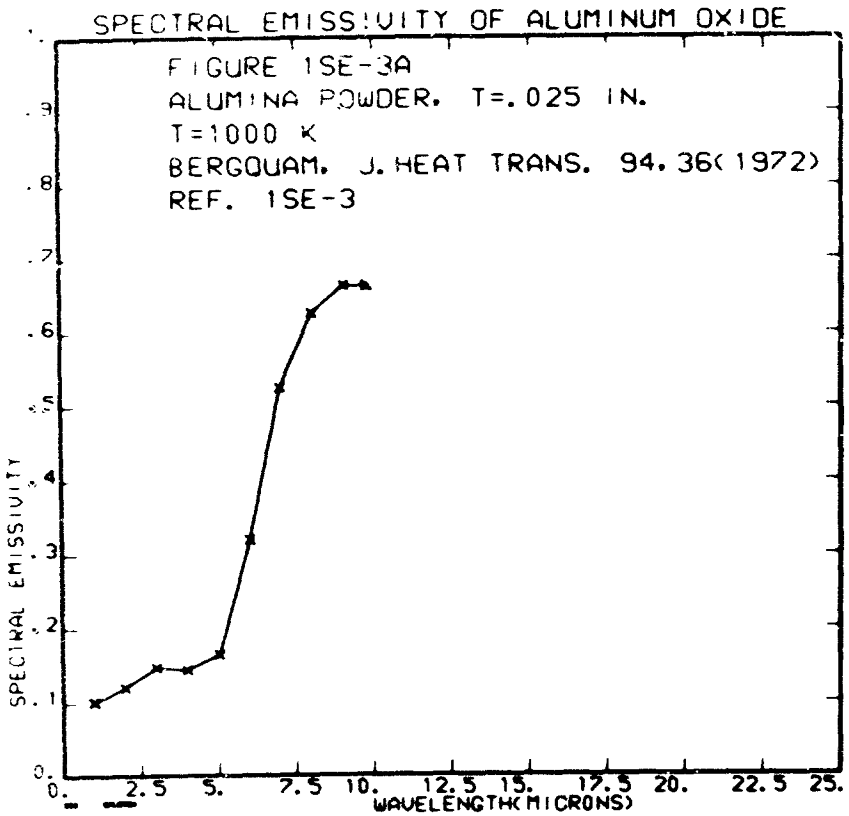
These data show values of $\epsilon(\lambda)$ very much lower than the representative curves of Section I-1.3.

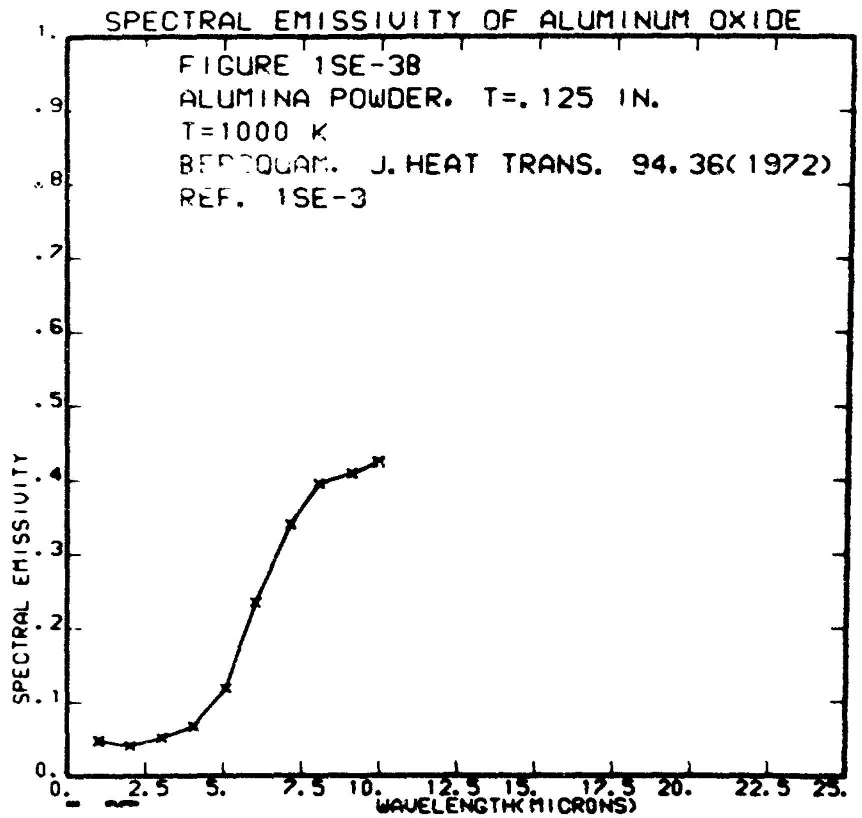
a. Thickness = 0.025 in., no compaction

λ	ε	λ	ε	λ	ε	λ	ε
1.011	.101	2.011	.121	3.008	.146	4.012	.144
5.054	.154	6.023	.320	7.022	.527	8.033	.627
9.064	.566	9.808	.664				

b. Thickness = 0.125 in., no compaction

λ	ε	λ	ε	λ	ε	λ	ε
1.015	.048	2.015	.041	3.026	.053	4.055	.067
5.083	.119	6.046	.234	7.128	.340	8.043	.395
9.074	.409	9.943	.425				


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-3A
ALUMINA POWDER. T=.025 IN.
T=1000 K
BERGQUAM. J.HEAT TRANS. 94.36(1972)
REF. 1SE-3
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0. .1 .2 .3 .4 .5 .6 .7 .8 .9


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-3B
ALUMINA POWDER. T=.125 IN.
T=1000 K
J.HEAT TRANS. 94.36(1972)
REF. 1SE-3
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.

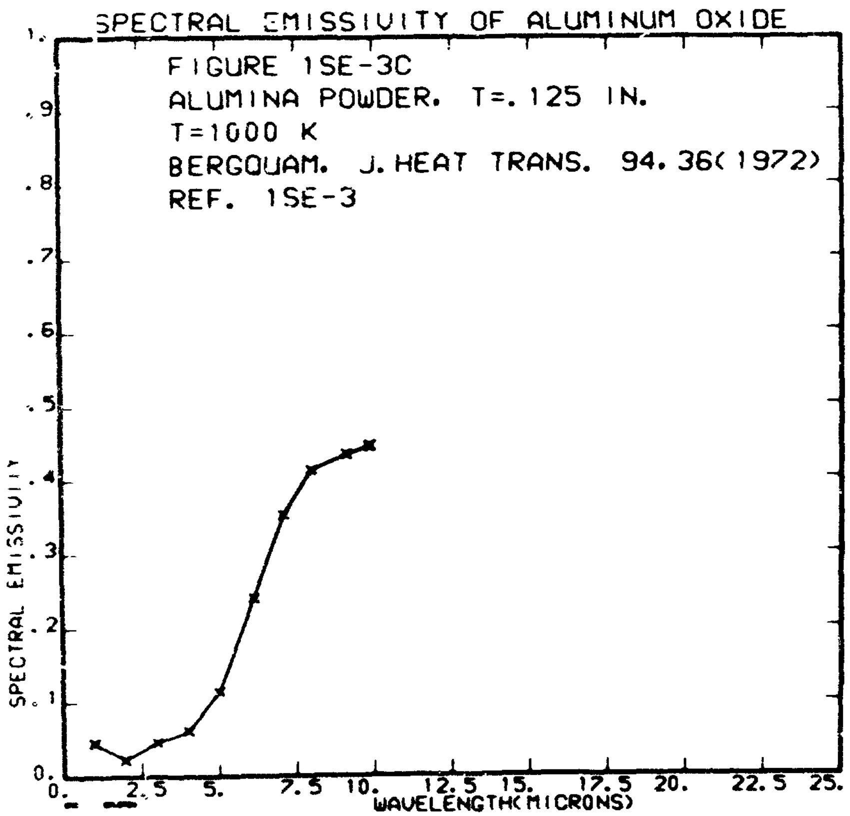
Bergquam (Ref. 1SE-3)

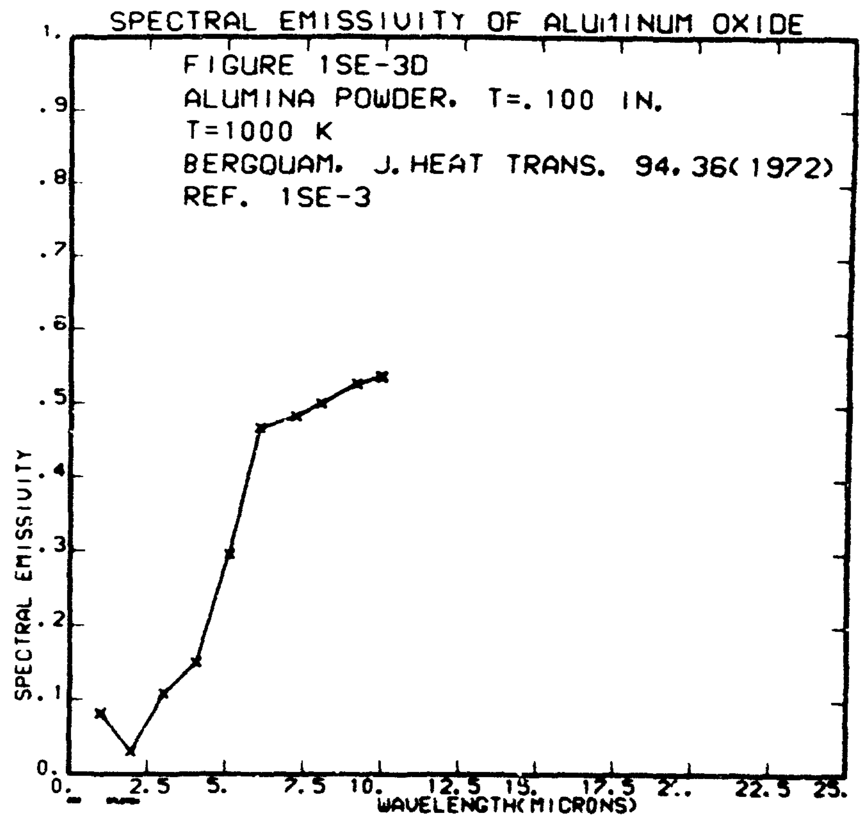
c. Thickness = 0.125 in., light compaction

λ	ε	λ	ε	λ	ε	λ	ε
1.008	.045	1.994	.023	3.029	.045	4.045	.061
5.044	.113	6.153	.239	7.120	.352	8.007	.413
9.128	.433	9.875	.444				

d. Thickness = 0.100 in., heavy compaction

λ	ε	λ	ε	λ	ε	λ	ε
1.015	.082	1.987	.030	3.031	.108	4.063	.150
5.096	.296	6.031	.468	7.158	.483	7.978	.502
9.118	.527	9.902	.538				


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-3C
ALUMINA POWDER. T=.125 IN.
T=1000 K
BERGQUAM. J. HEAT TRANS. 94. 36(1972)
REF. 1SE-3
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-3D
ALUMINA POWDER. T=.100 IN.
T=1000 K
BERGQUAM. J. HEAT TRANS. 94. 36(1972)
REF. 1SE-3
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
22.5
25.
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.

Blau (Ref. 1SE-4)

Samples of varying degrees of purity were held in a silicon carbide heating element at 873°K and 1303°K. Temperatures were measured by thermocouple and optical pyrometer, with an absolute precision estimated to be ± 1 percent. Emittances were measured using a prism spectrometer within specified resolutions and standard blackbody. Emittance errors are estimated to be ± 4 percent absolute, ± 2 percent relative. Essential features of $\epsilon(\lambda)$ for alumina from 85 to 99 percent pure are the same, and these data are representative of alumina. The data were digitized from discrete points.

a. Coors AD-85 Alumina (85 percent pure), T = 873°K

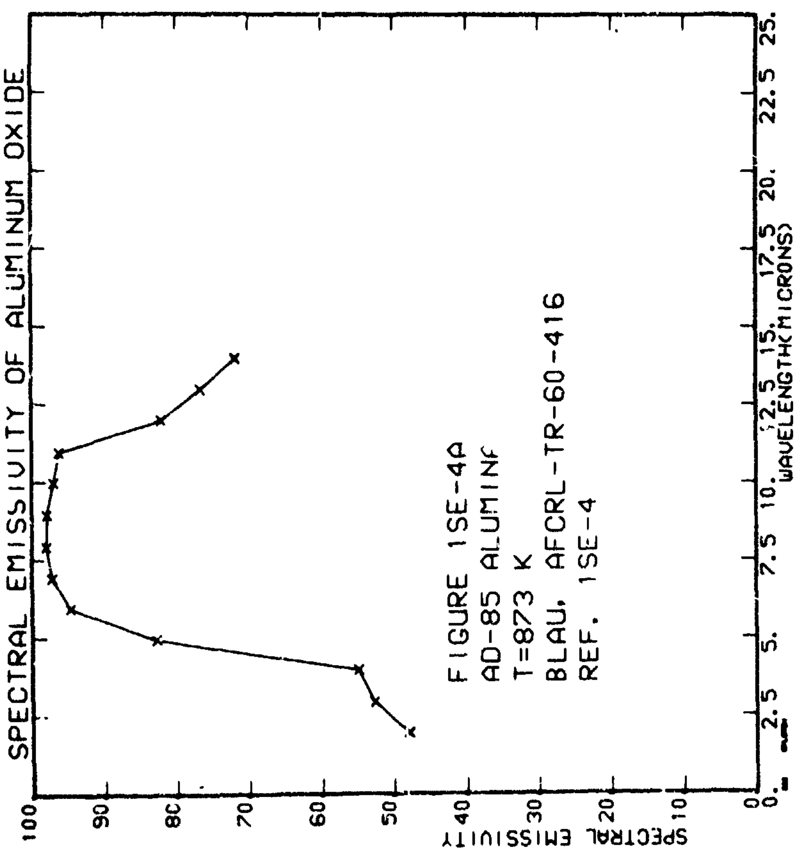
λ	ε	λ	ε	λ	ε	λ	ε
1.967	[illegible]	2.955	5.277E-01	3.988	5.497E-01	4.963	8.283E-01
[illegible]	[illegible]	6.941	9.729E-01	7.939	9.808E-01	8.962	9.792E-01
9.931	9.703E-01	10.972	9.632E-01	11.992	8.216E-01	12.995	7.560E-01
13.997	7.185E-01						

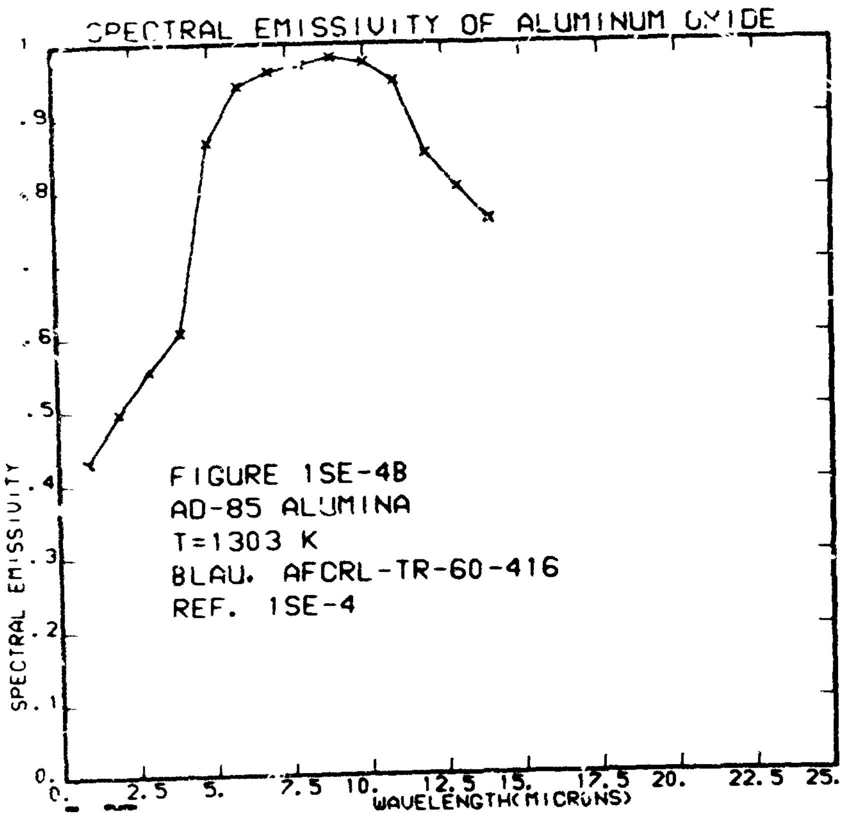
b. Coors AD-85 Alumina (85 percent pure), T = 1303°K.

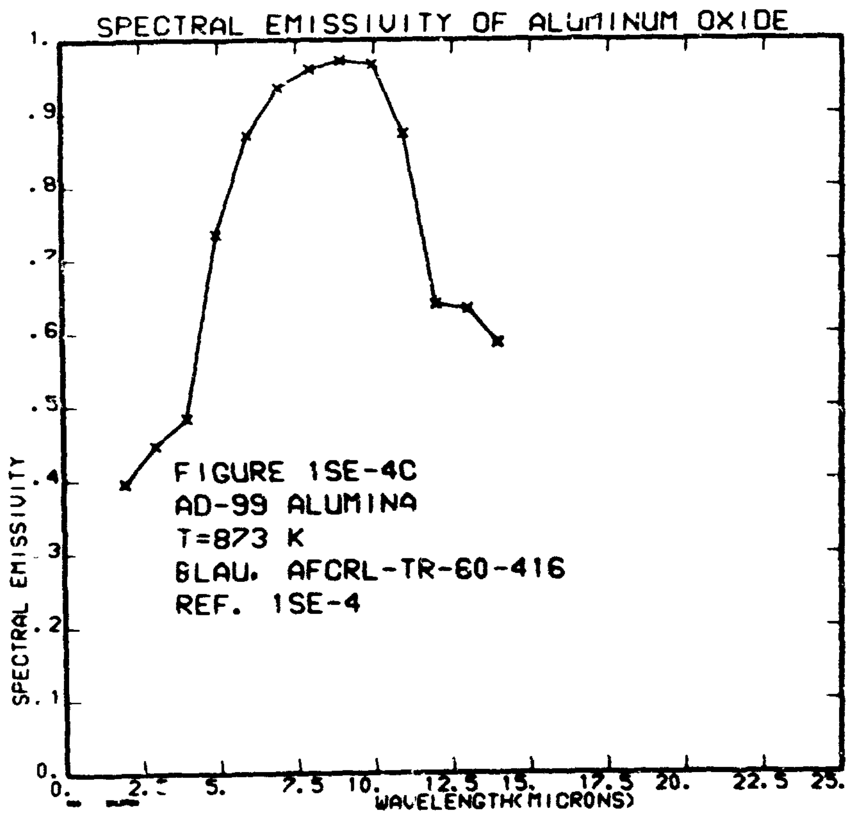
λ	ε	λ	ε	λ	ε	λ	ε
.950	.428	1.955	.496	2.955	.555	3.984	.606
4.933	.367	5.943	.943	6.947	.962	7.924	.971
8.943	.982	9.973	.974	10.955	.949	11.965	.850
12.956	.804	13.973	.759				

c. Coors AD-99 Alumina (99 percent pure), T = 873°K.

λ	ε	λ	ε	λ	ε	λ	ε
1.971	.395	2.958	.447	3.969	.485	4.934	.737
5.938	.871	6.935	.935	7.931	.960	8.947	.973
9.961	.967	10.931	.874	11.961	.640	12.986	.633
13.969	.583						


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-4A
AD-85 ALUMINA
T=873 K
BLAU, AFCRL-TR-60-416
REF. 1SE-4
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
100
90
80
70
60
50
40
30
20
10
0
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
FIGURE 1SE-4B
AD-85 ALUMINA
T=1303 K
BLAU. AFCRL-TR-60-416
REF. 1SE-4


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
FIGURE 1SE-4C
AD-99 ALUMINA
T=873 K
BLAU. AFCRL-TR-60-416
REF. 1SE-4

Blau (Ref. 1SE-4)

d. Coors AD-99 Alumina (99 percent pure), T = 1303°K.

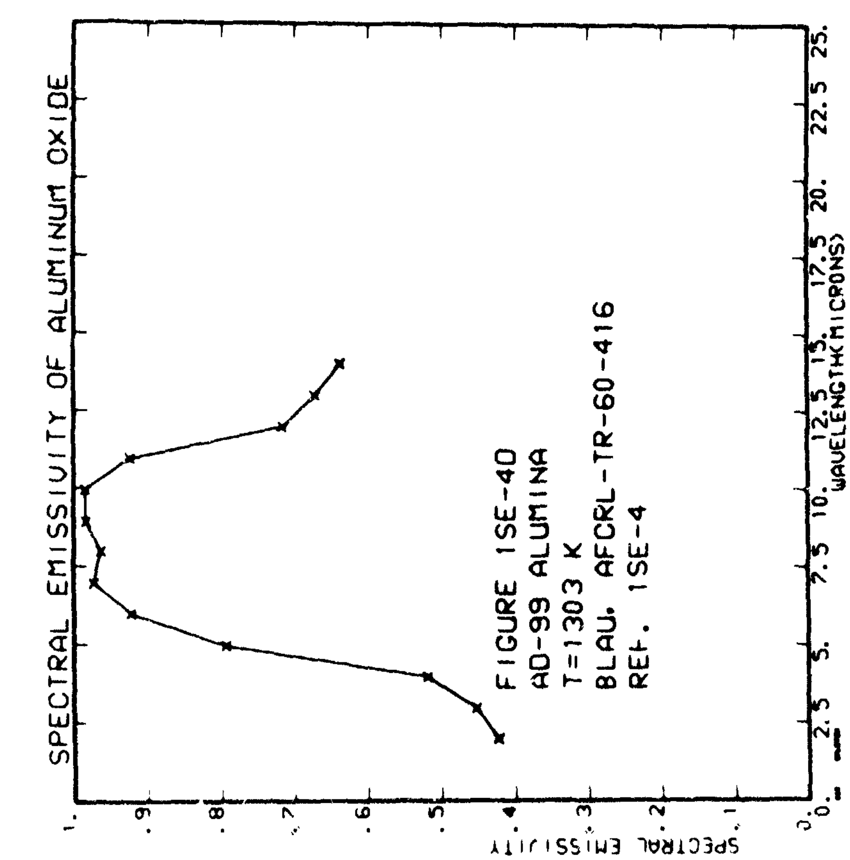
λ	ε	λ	ε	λ	ε	λ	ε
1.974	.422	2.967	.453	3.967	.520	4.970	.795
5.976	.923	5.957	.972	7.975	.964	8.942	.983
9.961	.934	10.971	.924	11.964	.717	12.935	.673
14.011	[illegible]						

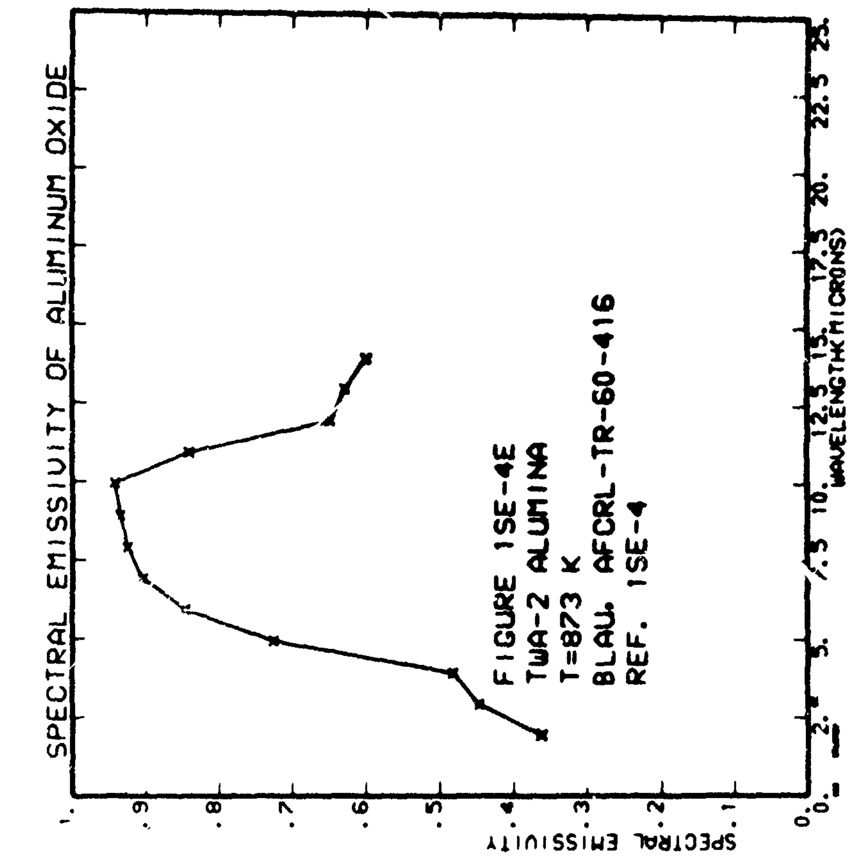
e. Norton TWA-2, A402 Alumina (98.56 percent pure), T = 873°K.

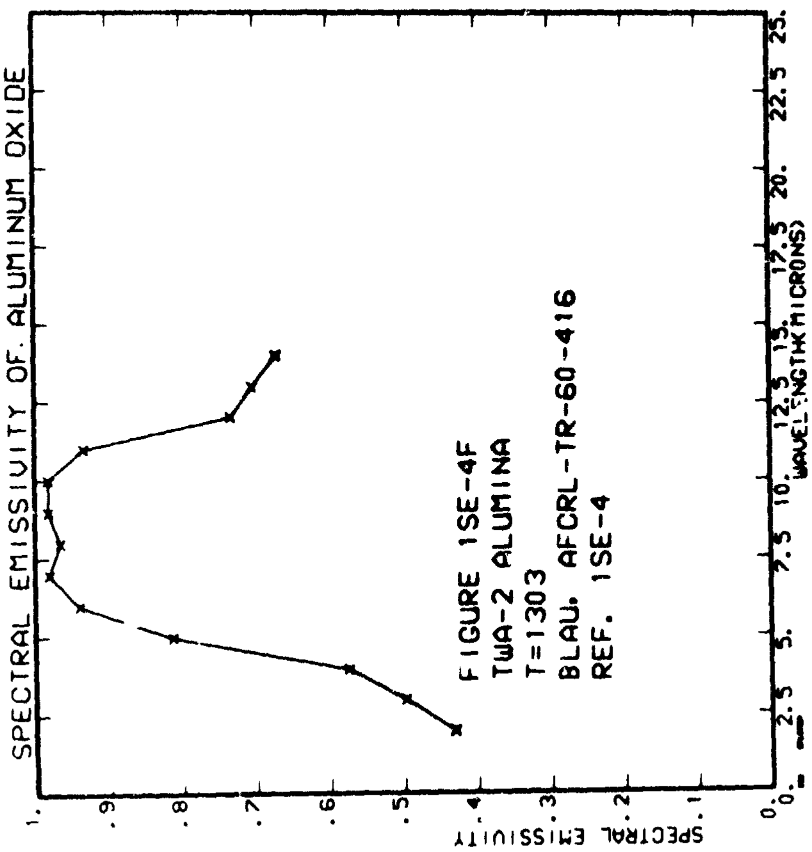
λ	ε	λ	ε	λ	ε	λ	ε
[illegible]	.563	2.937	.446	3.926	.482	4.941	.726
[illegible]	.845	6.932	.906	7.919	.925	8.931	.937
[illegible]	.944	[illegible]	.842	11.972	.650	12.974	.630
[illegible]	[illegible]						

f. Norton TWA-2, A402 Alumina (98.56 percent pure), T = 1303°K.

λ	ε	λ	ε	λ	ε	λ	ε
[illegible]	.431	2.937	.499	3.964	.576	4.997	.814
[illegible]	.341	5.982	.951	7.984	.966	8.995	.983
[illegible]	.383	11.105	.935	12.026	.734	12.999	.705
[illegible]	.072						


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-4D
AD-99 ALUMINA
T=1303 K
BLAU. AFCRL-TR-60-416
REF. 1SE-4
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-4E
TWA-2 ALUMINA
T=873 K
BLAU. AFCRL-TR-60-416
REF. 1SE-4
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-4F
TWA-2 ALUMINA
T=1303
BLAU. AFCRL-TR-60-416
REF. 1SE-4
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Carlson (Ref. ISE-6)

These data represent $\epsilon(\lambda)$ for liquid Al_2O_3 droplets 1 to 10 μin diameter in a rock[illegible] flame. A grating spectrometer with a tungsten comparitor source was used. These data indicate that a discontinuity at the alumina melting point occurs in $\epsilon(\lambda)$. No error analysis was given. Data were taken directly from a table.

a. $\lambda = 1.3\mu$

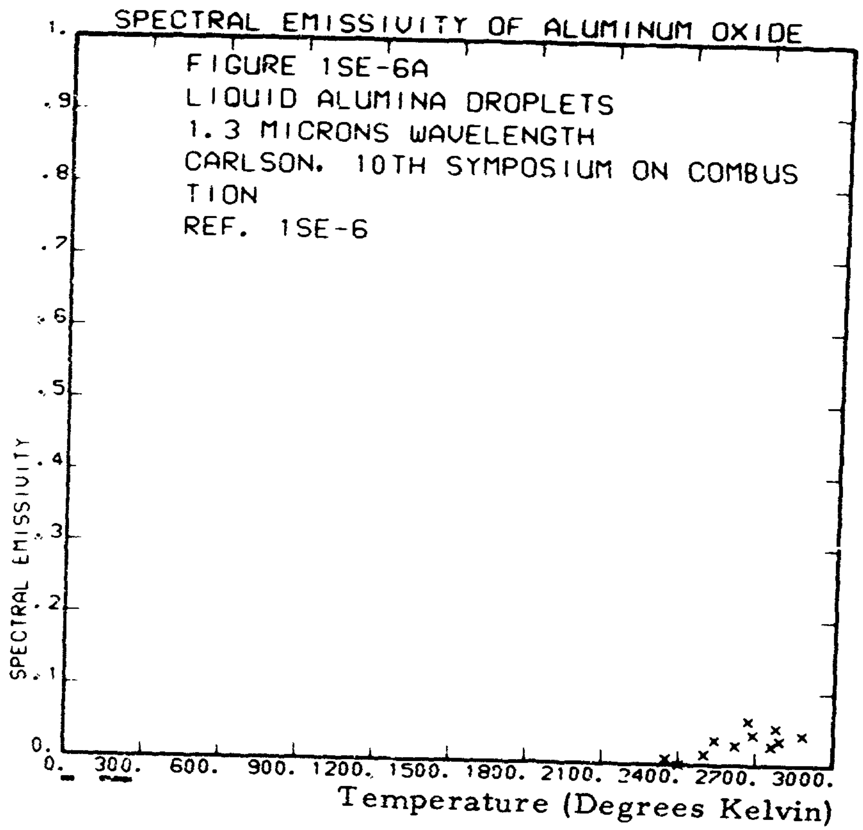
T	ε	T	ε	T	ε	T	ε
2800.000	.042	2550.000	.015	2750.000	.027	2620.000	.028
2790.000	.034	2920.000	.042	2950.000	.009	2400.000	.000
2540.000	.034	[illegible]	.052	2750.000	.051		

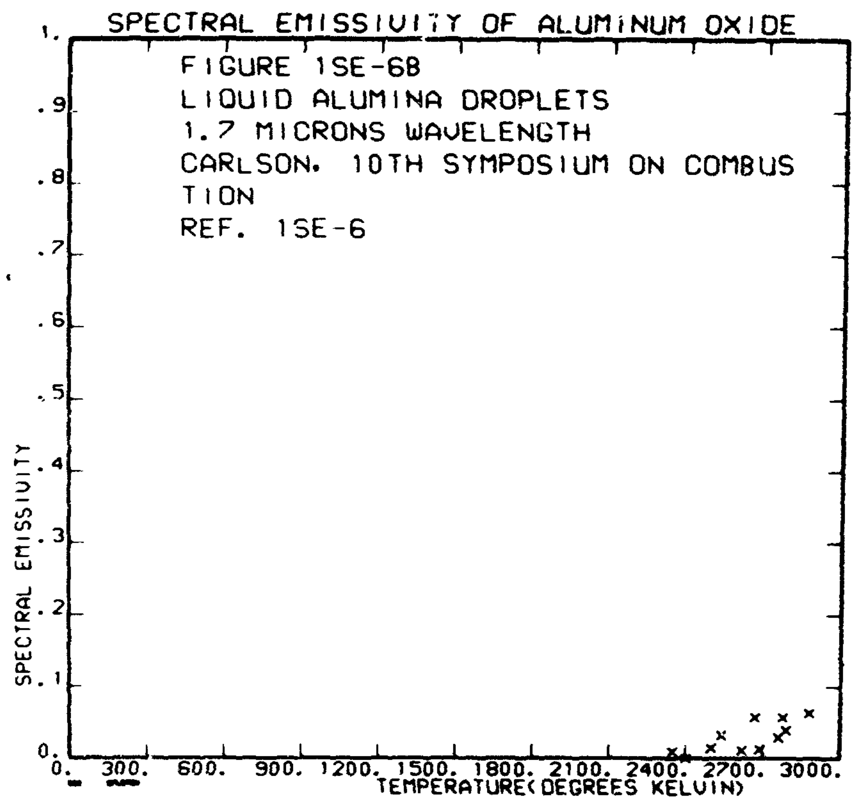
b. $\lambda = 1.7\mu$

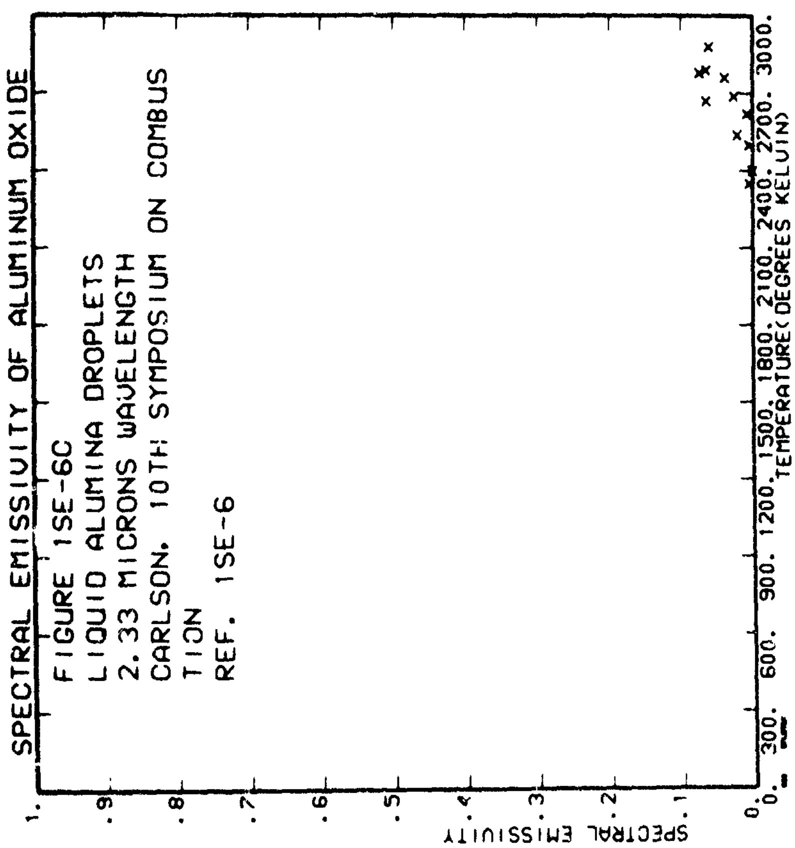
T	ε	T	ε	T	ε	T	ε
2650.000	.034	2550.000	.015	2760.000	.029	2620.000	.012
2730.000	.033	2990.000	.014	2550.000	.010	2400.000	.000
2540.000	.032	2570.000	.057	2750.000	.057		

c. $\lambda = 2.33\mu$

T	ε	T	ε	T	ε	T	ε
[illegible]	.031	[illegible]	.005	2760.000	.039	2620.000	.018
[illegible]	.020	2690.000	.025	2550.000	.025	2400.000	.000
[illegible]	.022	2570.000	.055	2750.000	.074		


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-6A
LIQUID ALUMINA DROPLETS
1.3 MICRONS WAVELENGTH
CARLSON. 10TH SYMPOSIUM ON COMBUS
TION
REF. 1SE-6
SPECTRAL EMISSIVITY
0.
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.
0.
300.
600.
900.
1200.
1500.
1800.
2100.
2400.
2700.
3000.
Temperature (Degrees Kelvin)


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-6B
LIQUID ALUMINA DROPLETS
1.7 MICRONS WAVELENGTH
CARLSON. 10TH SYMPOSIUM ON COMBUS
TION
REF. 1SE-6
SPECTRAL EMISSIVITY
0.
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.
0.
300.
600.
900.
1200.
1500.
1800.
2100.
2400.
2700.
3000.
TEMPERATURE(DEGREES KELVIN)



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-6C
LIQUID ALUMINA DROPLETS
2.33 MICRONS WAVELENGTH
CARLSON, 10TH SYMPOSIUM ON COMBUS
TION
REF. 1SE-6
SPECTRAL EMISSIVITY
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
TEMPERATURE(DEGREES KELVIN)
0. 300. 600. 900. 1200. 1500. 1800. 2100. 2400. 2700. 3000.

Clark (Ref. 1SE-8)

Alumina specimens, 99.2 percent pure in a hollow cylindrical form with smooth, but not polished, surfaces were used. Measurements were made using a rotating furnace system and a double beam NaCl prism spectrometer with an unspecified bandpass. Thermocouples were used for temperature measurement. Maximum error limits in $\epsilon(\lambda)$ were + 0.012, -0.032 (at 2 μ). These data were taken directly from a table.

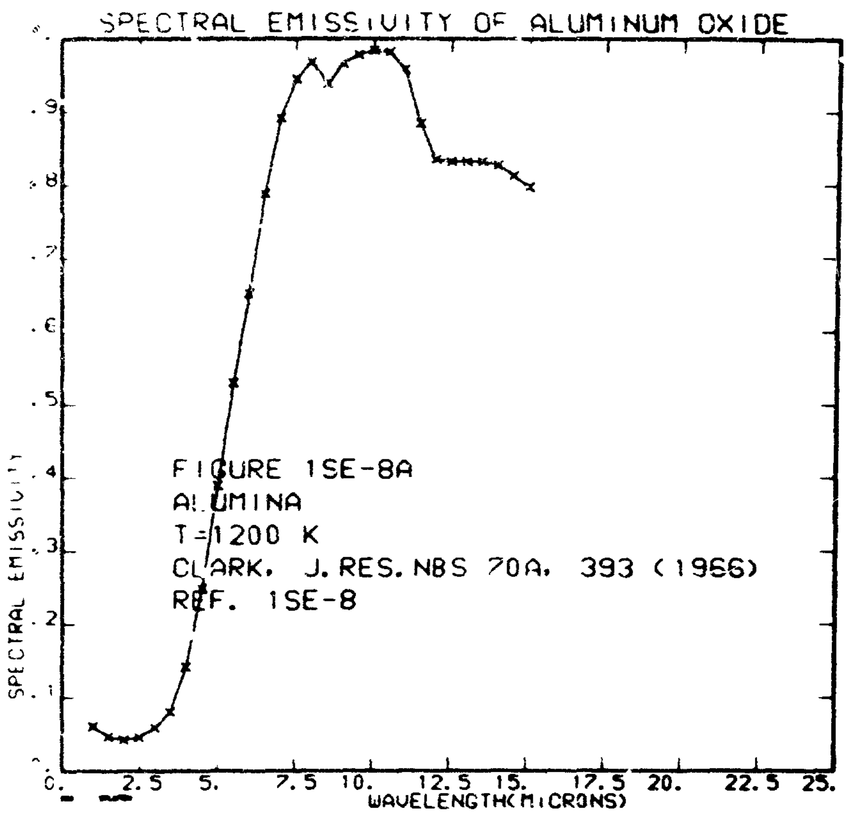
These data show $\epsilon(\lambda)$ higher than the representative curve given in Section I-1.3 for wavelengths longer than 12μ.

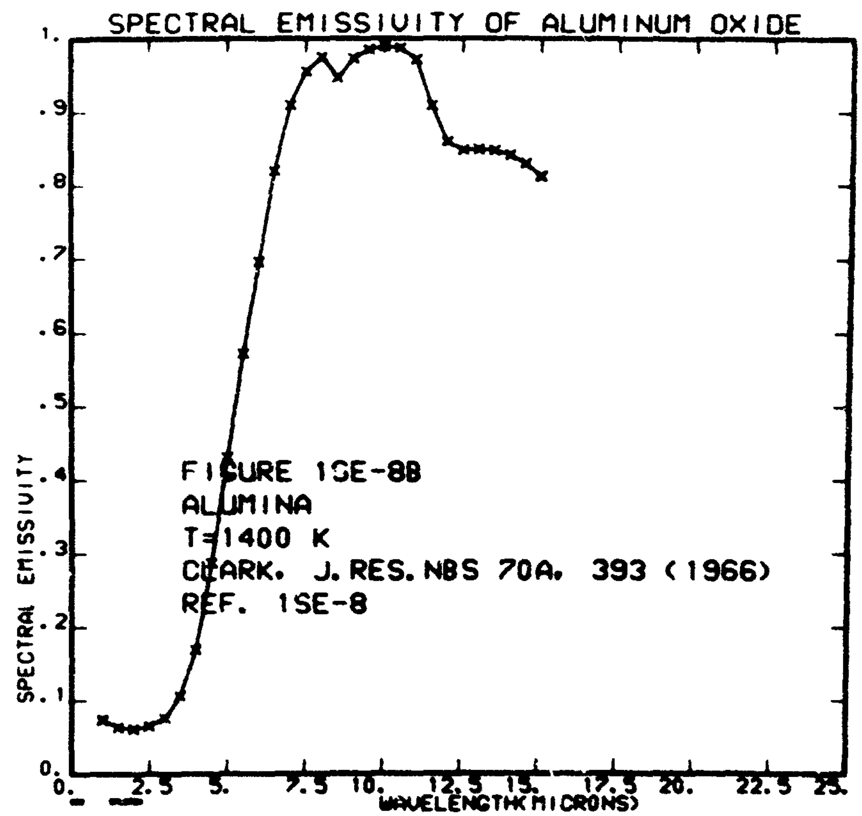
a. T = 1200°K

λ	ϵ	λ	ϵ	λ	ϵ	λ	ϵ
1.000	.060	1.500	.046	2.000	.042	2.500	.045
3.000	.058	3.500	.080	4.000	.141	4.500	.248
5.000	.389	5.500	.530	6.000	.653	6.500	.783
7.000	.892	7.500	.945	8.000	.968	8.500	.939
9.000	.965	9.500	.978	10.000	.984	10.500	.982
11.000	.958	11.500	.885	12.000	.836	12.500	.833
13.000	.833	13.500	.833	14.000	.828	14.500	.814
15.000	.799						

b. T = 1400°K

λ	ϵ	λ	ϵ	λ	ϵ	λ	ϵ
1.000	.073	1.500	.063	2.000	.061	2.500	.065
3.000	.075	3.500	.106	4.000	.169	4.500	.287
5.000	.431	5.500	.572	6.000	.696	6.500	.821
7.000	.910	7.500	.956	8.000	.975	8.500	.947
9.000	.973	9.500	.985	10.000	.989	10.500	.987
11.000	.972	11.500	.909	12.000	.860	12.500	.848
13.000	.849	13.500	.848	14.000	.841	14.500	.830
15.000	.813						

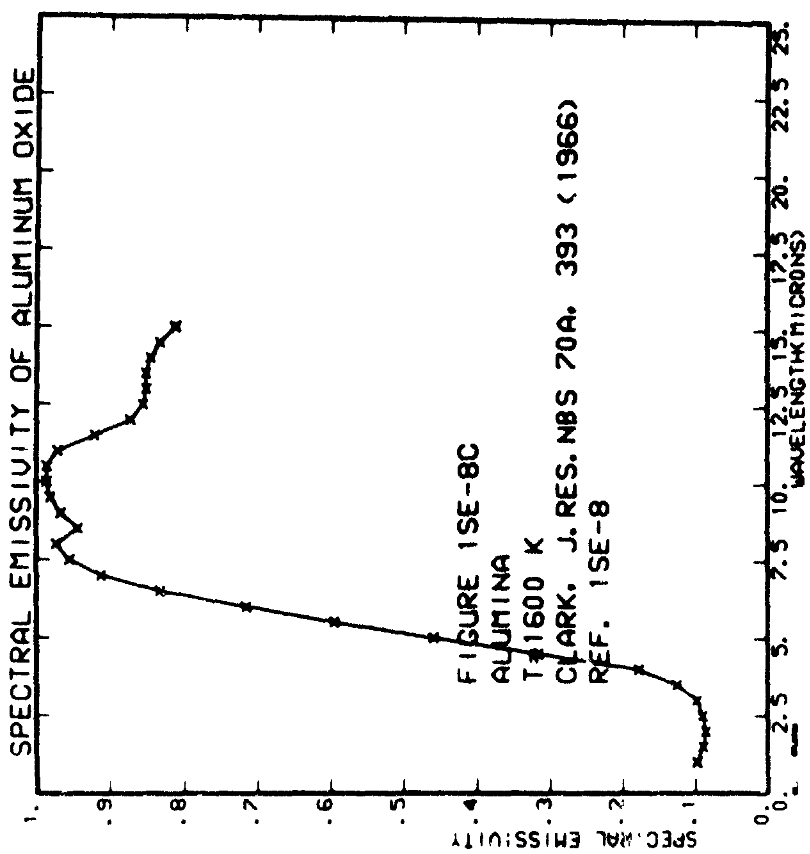

SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-8A
ALUMINA
T=1200 K
CLARK. J. RES. NBS 70A, 393 (1966)
REF. 1SE-8
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-8B
ALUMINA
T=1400 K
CLARK. J. RES. NBS 70A, 393 (1966)
REF. 1SE-8
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)

Clark (Ref. 1SE-8)

c. $T = 1600^{\circ}K$

λ	ϵ	λ	ϵ	λ	ϵ	λ	ϵ
1.000	.097	1.500	.088	2.000	.085	2.500	.089
3.000	.097	3.500	.125	4.000	.177	4.500	.316
5.000	.459	5.500	.595	6.000	.715	6.500	.832
7.000	.912	7.500	.955	8.000	.973	8.500	.944
9.000	.967	9.500	.981	10.000	.986	10.500	.986
11.000	.971	11.500	.921	12.000	.873	12.500	.856
13.000	.852	13.500	.852	14.000	.846	14.500	.833
15.000	.813						


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-8C
ALUMINA
T=1600 K
CLARK. J.RES.NBS 70A. 393 (1966)
REF. 1SE-8
SPECTRAL EMISSIVITY
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Mergerian (Ref. 1SE-11)

The spectral emissivity of a rotating Linde sapphire sample in a furnace containing a blackbody reference was measured using an NaCl double pass prism monochromator with a band-pass of approximately 0.25 μ. Precision was not specifically stated. These data were digitized from discrete points.

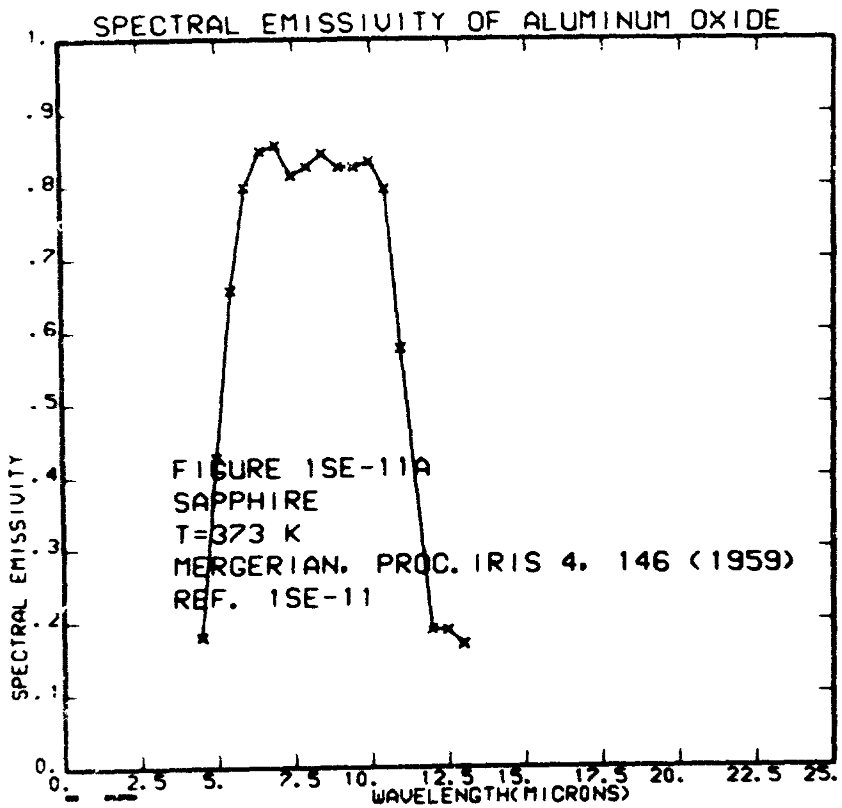
These data are in good agreement with the representative curves of Section I-1.3.

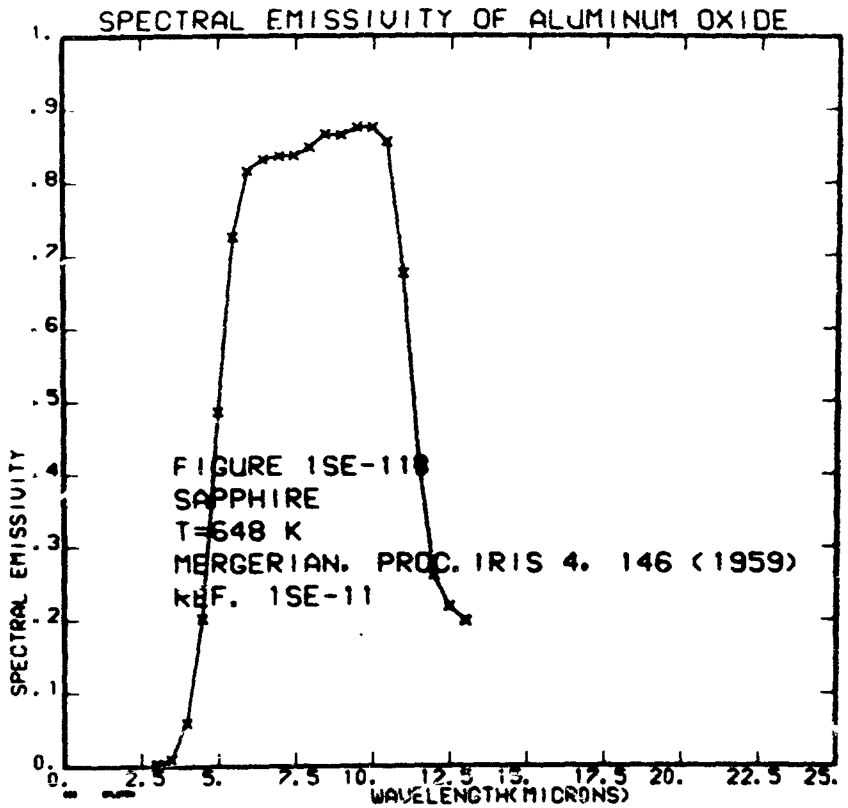
a. T = 373°K

λ	ε	λ	ε	λ	ε	λ	ε
4.475	.178	4.979	.425	5.451	.657	5.94[illegible]	.798
6.443	.848	6.932	.857	7.430	.814	7.933	.827
8.432	.846	8.957	.825	9.462	.827	9.953	.834
10.451	.795	10.959	.577	11.963	.189	12.491	.188
12.336	.159						

b. T = 648°K

λ	ε	λ	ε	λ	ε	λ	ε
3.002	.004	3.496	.010	3.985	.059	4.486	.201
4.935	.457	5.468	.726	5.935	.817	6.446	.832
6.956	.837	7.440	.837	7.927	.849	8.443	.867
8.951	.866	9.458	.875	9.952	.876	10.445	.856
10.965	.677	11.481	.416	11.984	.261	12.494	.218
13.005	.199						


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-11A
SAPPHIRE
T=373 K
MERGERIAN. PROC. IRIS 4. 146 (1959)
REF. 1SE-11
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-11B
SAPPHIRE
T=648 K
MERGERIAN. PROC. IRIS 4. 146 (1959)
REF. 1SE-11
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

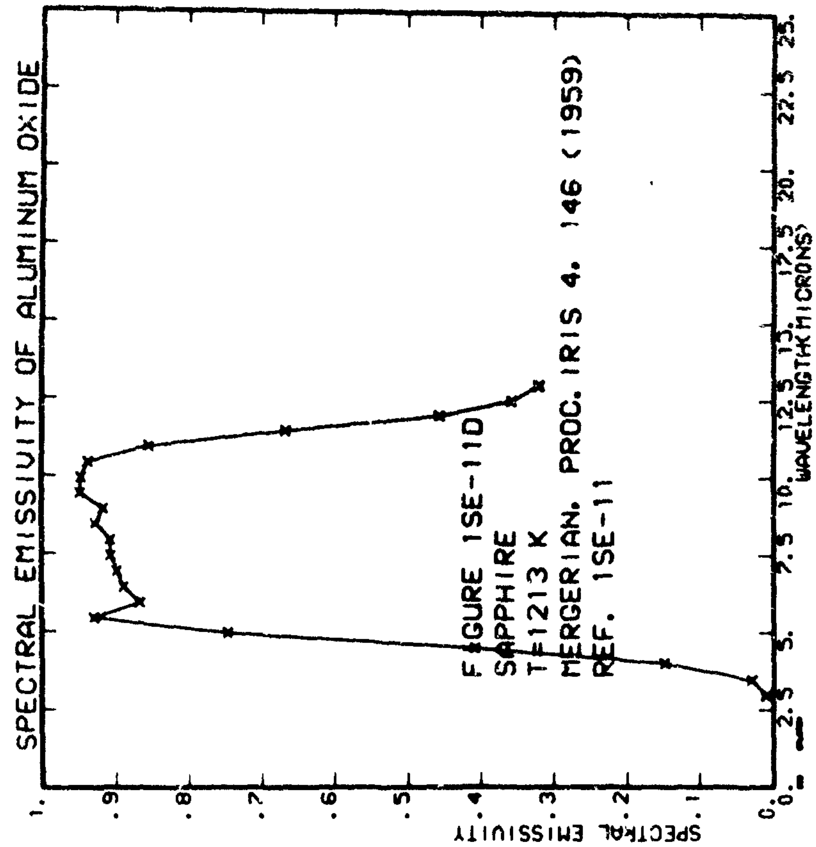
Mergerian (Ref. 1SE-11)

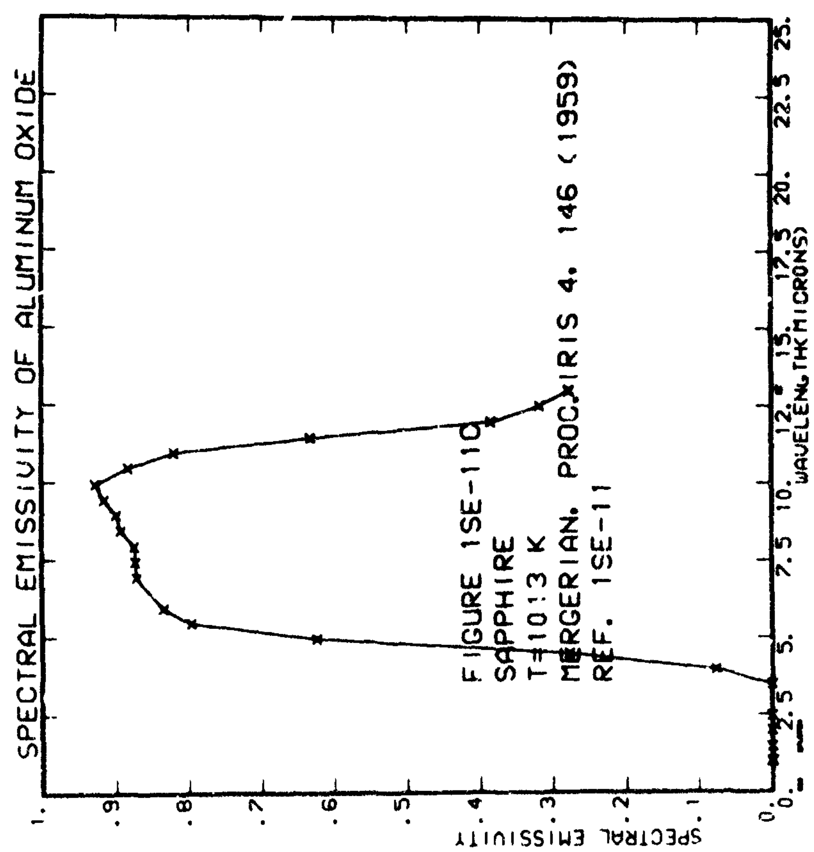
c. T = 1013^{o}K

λ	ε	λ	ε	λ	ε	λ	ε
1.[illegible]2	.[illegible]	1.493	.000	2.001	.000	2.491	.000
3.5[illegible]7	.[illegible]	3.993	.078	4.479	.278	4.364	.626
5.[illegible]6[illegible]	.797	5.937	.835	6.938	.871	7.439	.873
7.333	.374	8.447	.894	8.943	.901	9.437	.917
9.935	.927	1[illegible].457	.883	10.949	.821	11.447	.634
11.960	.385	12.483	.317	12.981	.277		

d. T = 1213^{o}K

λ	ε	λ	ε	λ	ε	λ	ε
[illegible].991	.010	3.492	.628	4.003	.148	4.474	.408
[illegible].966	.748	5.439	.929	5.937	.866	6.438	.890
5.935	.339	[illegible].430	.908	7.944	.908	8.464	.927
8.947	.919	9.443	.948	9.938	.947	10.426	.938
1[illegible].961	.550	11.449	.663	11.964	.458	12.469	.359
12.969	.320						


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-11D
SAPPHIRE
T=1213 K
MERGERIAN. PROC. IRIS 4. 146 (1959)
REF. 1SE-11
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-11C
SAPPHIRE
T=1013 K
MERGERIAN. PROC. IRIS 4. 146 (1959)
REF. 1SE-11
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Richmond (Ref. 1SE-12)

$\epsilon(\lambda)$ for alumina was measured at an unspecified temperature using the NBS rotating cylinder method (Ref. 1SE-7, 1SE-8) to determine the degree to which $\epsilon(\lambda)$ is a function of surface roughness. It was found that no appreciable change in emissivity occurred below 14 μ after the smooth alumina was grit blasted. The peak at 3 μ is attributable to water. No errc analysis is given. The data points were digitized from a curve.

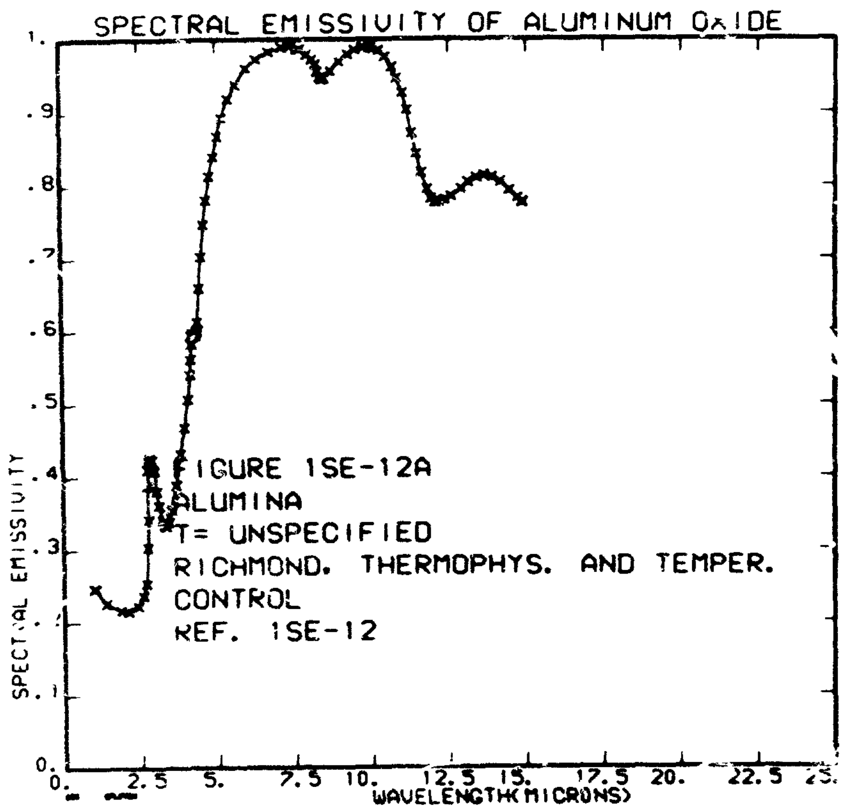
a. Before grit blasting.

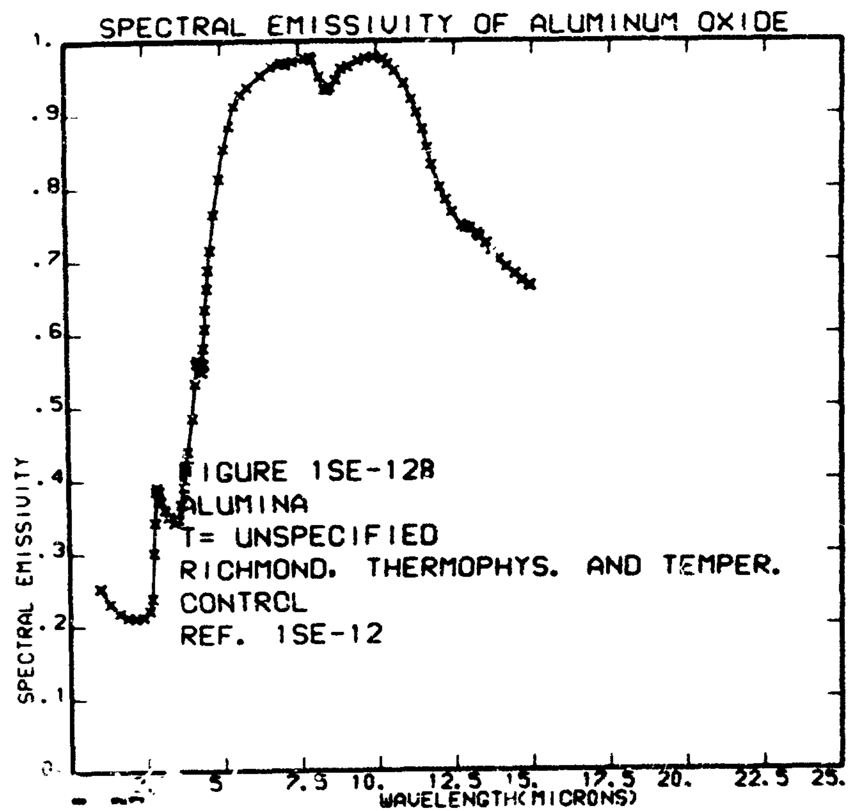
λ	ε	λ	ε	λ	ε	λ	ε
1.021	.246	1.590	.226	1.349	.216	2.090	.216
2.402	.223	2.582	.237	2.677	.253	2.724	.303
2.750	.341	2.744	.388	2.744	.416	2.780	.422
2.820	.426	2.891	.424	2.966	.409	3.041	.381
3.120	.351	3.200	.341	3.275	.334	3.325	.332
3.403	.338	3.490	.357	3.654	.389	3.313	.432
3.940	.459	4.061	.507	4.136	.541	4.164	.562
4.187	.533	4.187	.595	4.221	.598	4.258	.596
4.320	.595	4.349	.600	4.376	.613	4.438	.660
4.563	.704	4.665	.747	4.595	.781	4.816	.814
4.925	.841	5.061	.808	5.260	.893	5.419	.921
5.554	.939	6.009	.961	6.336	.973	6.724	.984
7.160	.989	7.426	.991	7.747	.988	7.969	.979
8.130	.972	8.253	.966	8.321	.957	8.335	.949
8.451	.946	8.543	.947	8.741	.958	9.004	.970
9.275	.980	9.520	.986	9.786	.989	10.022	.989
10.291	.985	10.487	.976	10.701	.963	10.869	.947
11.026	.928	11.186	.904	11.336	.872	11.476	.845
11.651	.819	11.824	.796	11.964	.783	12.087	.779
12.215	.778	12.402	.782	12.619	.786	12.926	.796
13.171	.805	13.433	.911	13.690	.814	13.946	.812
14.207	.805	14.490	.795	14.761	.784	14.902	.778

Richmond (Ref. ISE-12)

b. After grit blasting.

λ	ε	λ	ε	λ	ε	λ	ε
1.915	.252	1.306	.230	1.668	.217	1.894	.211
2.123	.210	2.387	.211	2.586	.220	2.678	.238
2.730	.300	2.776	.341	2.825	.395	2.864	.390
2.917	.386	2.973	.372	3.120	.360	3.237	.349
3.414	.341	3.528	.346	3.624	.367	3.740	.390
3.704	.413	3.850	.438	3.998	.485	4.117	.532
4.171	.559	4.202	.565	4.262	.560	4.231	.551
4.332	.549	4.379	.559	4.393	.581	4.425	.607
4.464	.635	4.509	.663	4.561	.688	4.630	.716
4.765	.755	4.932	.814	5.393	.855	5.256	.885
5.428	.913	5.628	.928	5.867	.938	6.300	.954
6.036	.960	6.949	.970	7.098	.969	7.339	.972
7.746	.977	7.879	.979	7.944	.975	8.182	.953
8.343	.936	8.424	.935	8.519	.938	8.713	.949
8.897	.954	9.117	.966	9.439	.974	9.668	.978
9.924	.978	10.229	.977	10.397	.970	10.616	.960
10.395	.943	11.126	.922	11.304	.903	11.477	.880
11.630	.855	11.763	.832	12.038	.801	12.223	.785
12.437	.768	12.746	.749	12.867	.745	12.999	.745
13.223	.739	13.306	.733	13.529	.724	13.712	.715
13.934	.793	14.185	.693	14.462	.633	14.690	.674
14.929	.665						


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-12A
ALUMINA
T= UNSPECIFIED
RICHMOND. THERMOPHYS. AND TEMPER.
CONTROL
REF. 1SE-12
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

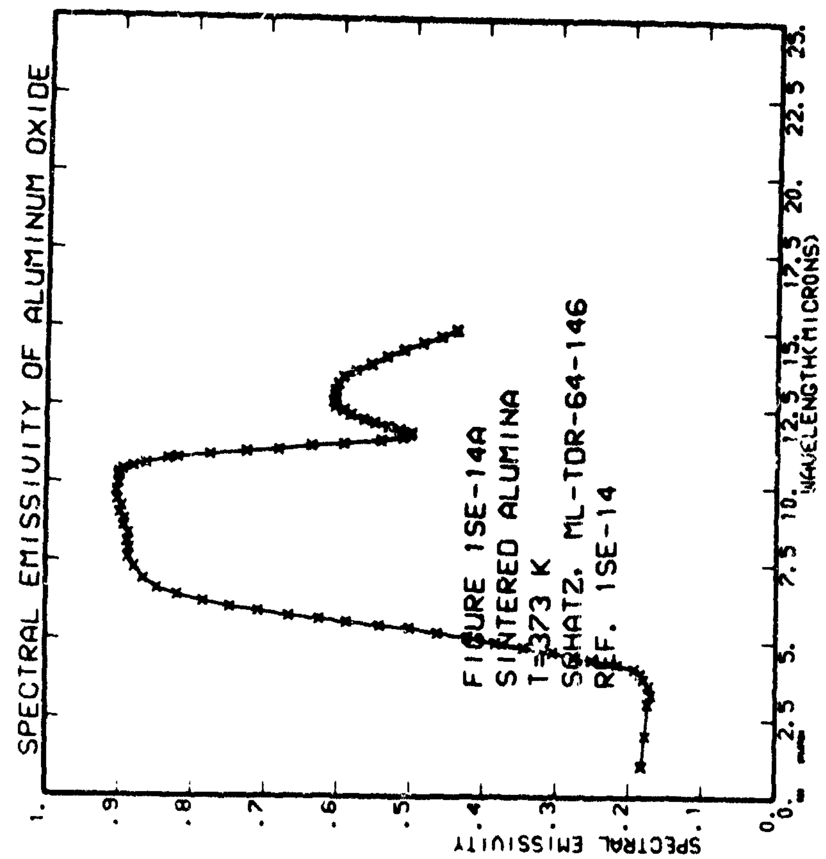

SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-12B
ALUMINA
T= UNSPECIFIED
RICHMOND. THERMOPHYS. AND TEMPER.
CONTROL
REF. 1SE-12
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
.1 .2 .3 .4 .5 .6 .7 .8 .9 1.
5 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Schatz (Ref. 1SE-14)

Spectral emissivity was measured for sintered Al_2O_3, 99 percent pure, from Linde Co. using a double beam spectrometer with unspecified bandpass and a standard blackbody. The sample was heated by conduction from a holder. The estimated accuracy is to within 5 percent for $\lambda > 2\ \mu$. Data are digitized from curves and in very good agreement with the representative curves given in Section I-1.3, except for a small peak at 13μ. T = 373°K, 885°K, 1003°K, 1148°K, and 1273°K.

a. T = 373°K

λ	ε	λ	ε	λ	ε	λ	ε
1.005	.182	1.984	.177	3.011	.174	3.315	.171
3.607	.174	3.317	.180	3.980	.184	4.126	.193
4.291	.216	4.415	.251	4.504	.275	4.636	.306
4.792	.345	4.943	.383	5.098	.422	5.246	.464
5.375	.593	5.472	.544	5.575	.588	5.677	.626
5.793	.567	5.937	.710	6.068	.748	6.234	.787
6.447	.822	6.623	.849	6.938	.869	7.317	.881
7.619	.889	7.916	.898	8.121	.890	8.373	.889
8.634	.934	8.847	.894	9.029	.900	9.252	.897
9.469	.903	9.727	.914	9.977	.902	10.223	.902
10.327	.901	10.430	.890	10.530	.882	10.635	.865
10.779	.835	10.839	.822	10.935	.779	11.030	.729
11.122	.684	11.225	.639	11.308	.595	11.410	.543
11.509	.512	11.584	.504	11.656	.502	11.751	.518
11.865	.534	11.987	.553	12.061	.567	12.225	.585
12.379	.596	12.520	.606	12.672	.610	12.852	.587
13.012	.606	13.243	.602	13.460	.596	13.645	.580
13.858	.557	14.098	.535	14.325	.512	14.565	.487
14.758	.452	14.995	.440				


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-14A
SINTERED ALUMINA
T=373 K
SCHATZ. ML-TDR-64-146
REF. 1SE-14
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

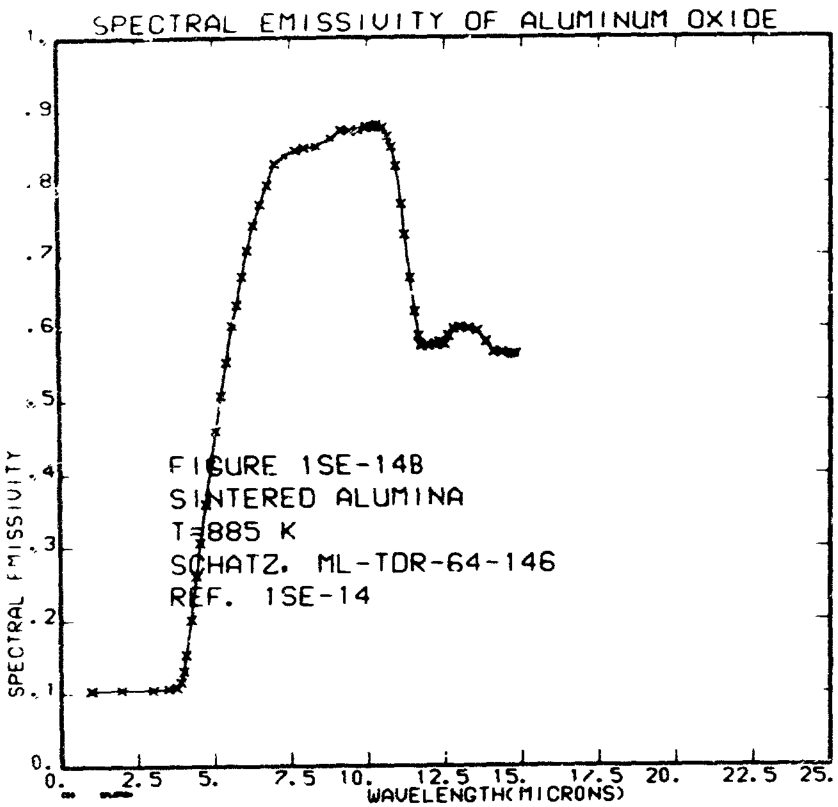
Schatz (Ref. 1SE-14)

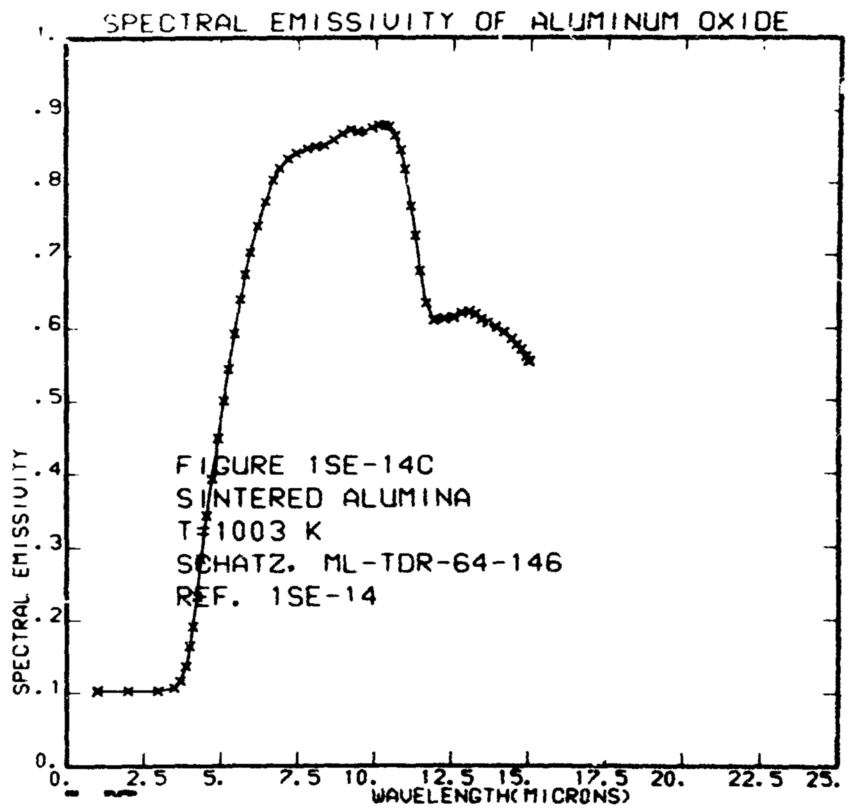
b. T = 885°K

λ	ε	λ	ε	λ	ε	λ	ε
1.002	.104	1.993	.104	3.007	.104	3.513	.107
3.793	.108	3.921	.115	4.000	.130	4.094	.152
4.254	.201	4.444	.200	4.569	.305	4.739	.358
4.911	.414	5.070	.460	5.226	.507	5.412	.555
5.606	.503	5.766	.632	5.933	.671	6.101	.707
6.306	.743	6.538	.771	6.753	.797	7.014	.827
7.342	.837	7.595	.846	7.363	.850	8.358	.851
8.335	.863	9.138	.874	9.429	.873	9.698	.874
9.952	.879	10.144	.878	10.279	.880	10.477	.877
10.632	.866	10.763	.856	10.923	.823	11.098	.772
11.217	.729	11.387	.609	11.523	.623	11.654	.689
11.735	.576	11.972	.576	12.204	.577	12.348	.580
12.495	.578	12.028	.589	12.781	.599	12.993	.602
13.279	.600	13.551	.536	13.356	.581	14.087	.567
14.368	.567	14.076	.564	14.795	.564		

c. T = 1003°K

λ	ε	λ	ε	λ	ε	λ	ε
1.011	.102	2.001	.102	2.982	.102	3.518	.107
3.712	.115	3.383	.137	4.000	.164	4.101	.190
4.229	.233	4.371	.284	4.544	.343	4.705	.394
4.963	.459	5.186	.501	5.244	.544	5.431	.594
5.623	.645	5.764	.674	5.945	.706	6.174	.741
6.428	.775	6.568	.816	6.894	.822	7.156	.834
7.446	.843	7.779	.843	8.053	.851	8.347	.852
8.640	.869	8.916	.869	9.175	.875	9.421	.873
9.574	.872	9.375	.878	10.077	.881	10.293	.880
10.424	.879	10.615	.806	10.803	.847	10.347	.821
11.129	.770	11.276	.729	11.439	.680	11.636	.635
11.891	.612	12.253	.614	12.537	.615	12.73[illegible]	.621
13.245	.624	13.244	.619	13.446	.613	13.63[illegible]	.609
13.919	.632	14.149	.595	14.405	.587	14.578	.579
14.729	.571	14.881	.562	14.989	.554		


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-14B
SINTERED ALUMINA
T=885 K
SCHATZ. ML-TDR-64-146
REF. 1SE-14
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-14C
SINTERED ALUMINA
T=1003 K
SCHATZ. ML-TDR-64-146
REF. 1SE-14
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

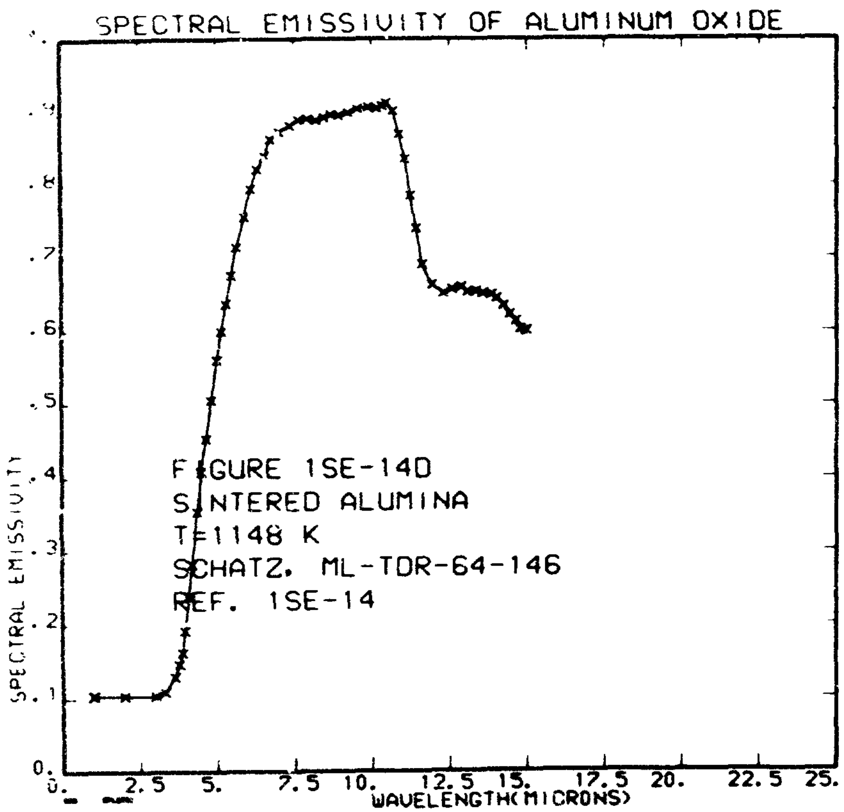
Schatz (Ref. 1SE-14)

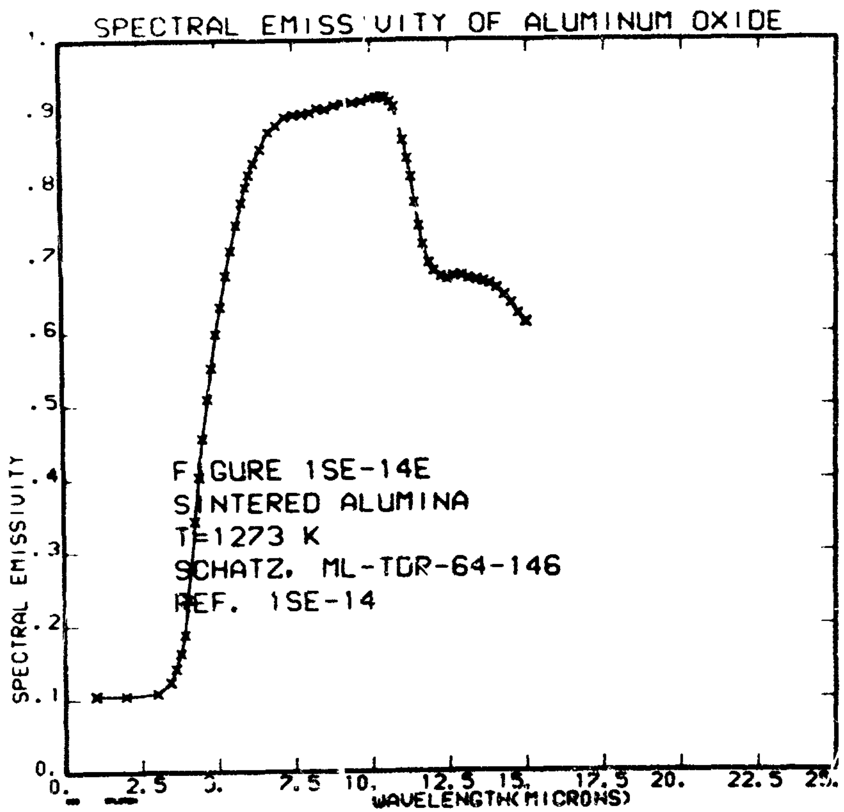
d. T = 1148°K

λ	ε	λ	ε	λ	ε	λ	ε
1.304	.104	2.000	.104	2.598	.104	3.304	.108
3.540	.128	3.792	.146	3.981	.161	3.969	.191
4.190	.238	4.192	.282	4.355	.353	4.489	.407
4.825	.454	4.798	.500	4.985	.560	5.145	.600
5.294	.637	5.455	.677	5.638	.714	5.875	.757
6.299	.794	6.322	.822	6.548	.839	6.769	.853
7.339	.373	7.381	.832	7.662	.889	7.962	.891
8.233	.819	8.469	.892	8.716	.896	8.965	.896
9.264	.839	9.562	.905	9.311	.907	10.177	.906
10.363	.978	10.494	.912	10.598	.901	10.906	.870
11.367	.835	11.249	.785	11.429	.741	11.635	.692
11.835	.654	12.306	.653	12.576	.658	12.878	.661
13.079	.654	13.362	.656	13.569	.652	13.851	.651
14.031	.645	14.257	.635	14.470	.623	14.666	.615
14.821	.694	14.973	.602				

e. T = 1273°K

λ	ε	λ	ε	λ	ε	λ	ε
1.905	.104	1.995	.104	3.010	.107	3.436	.122
3.618	.140	3.785	.161	3.905	.188	4.021	.235
4.123	.232	4.348	.342	4.391	.403	4.522	.457
4.673	.509	4.861	.553	4.956	.598	5.100	.635
5.277	.679	5.450	.711	5.641	.748	5.829	.778
5.966	.798	6.060	.815	6.221	.832	6.441	.851
6.716	.873	6.950	.832	7.244	.894	7.533	.897
7.798	.899	8.002	.900	8.288	.906	8.559	.905
8.842	.911	9.102	.914	9.423	.914	9.716	.915
9.988	.919	10.155	.921	10.323	.922	10.455	.921
10.513	.916	10.747	.908	10.893	.886	11.023	.862
11.154	.837	11.276	.812	11.412	.778	11.527	.747
11.569	.720	11.845	.695	12.020	.684	12.249	.677
12.445	.574	12.560	.679	12.915	.678	13.146	.674
13.393	.672	13.502	.670	13.818	.667	14.029	.652
14.291	.651	14.516	.641	14.747	.627	14.973	.614


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-14D
SINTERED ALUMINA
T=1148 K
SCHATZ, ML-TDR-64-146
REF. 1SE-14
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
.1
.2
.3
.4
.5
.6
.7
.8
.9
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-14E
SINTERED ALUMINA
T=1273 K
SCHATZ, ML-TDR-64-146
REF. 1SE-14
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
.1
.2
.3
.4
.5
.6
.7
.8
.9
2.5
7.5
10.
12.5
15.
17.5
20.
22.5

Stierwalt (Ref. 1SE-16)

Sapphire, purity and crystal orientation unspecified, 0.79 mm thick, was studied using three single beam spectrometers to cover the entire spectral range of 4 μ to 125 μ using the standard blackbody comparison method. A temperature range of 4.2°K to 200°K was surveyed. An error analysis was not given. These data were digitized from curves.

These data were selected as representative spectral emittances in Section I-1.3 for sapphire above 12 μ, and are in good agreement with the representative data below 12 μ (Figure I-1.3.1).

a. T = 4.2°K, 77°K, and 200°K, $\lambda < 24.1\ \mu$.

λ	ε	λ	ε	λ	ε
4.326	7.776E-02	4.232	7.359E-02	4.377	7.125E-02
4.510	8.153E-02	4.748	9.475E-02	4.973	1.115E-01
5.163	1.345E-01	5.342	1.505E-01	5.523	1.910E-01
5.744	2.425E-01	5.914	2.959E-01	6.068	3.570E-01
6.176	4.355E-01	6.311	5.312E-01	6.444	6.175E-01
6.531	5.938E-01	6.732	7.712E-01	6.896	8.448E-01
7.010	8.770E-01	7.145	9.605E-01	7.300	9.271E-01
7.[illegible]	9.6[illegible]E-01	7.655	9.529E-01	8.025	9.621E-01
8.336	9.635E-01	8.330	9.719E-01	9.254	9.744E-01
9.511	9.711E-01	9.489	9.562E-01	10.135	9.545E-01
10.354	9.289E-01	10.556	8.788E-01	10.723	8.240E-01
10.830	7.760E-01	11.015	6.758E-01	11.142	5.947E-01
11.254	5.023E-01	11.331	4.060E-01	11.345	3.479E-01
11.415	3.312E-01	11.523	3.161E-01	11.674	2.844E-01
11.7[illegible]	2.547E-01	11.869	2.395E-01	12.095	2.243E-01
12.342	2.156E-01	12.533	2.077E-01	12.709	1.935E-01
12.[illegible]	1.825E-01	13.036	1.710E-01	13.297	1.673E-01
13.320	1.552E-01	13.710	1.410E-01	13.843	1.268E-01
13.97[illegible]	1.165E-01	14.199	1.125E-01	14.590	1.135E-01
14.496	1.138E-01	15.036	1.280E-01	15.238	1.675E-01
15.343	1.990E-01	15.514	2.202E-01	15.867	2.795E-01
16.207	2.322E-01	16.181	1.920E-01	16.386	2.072E-01
16.545	2.430E-01	16.728	2.683E-01	16.866	3.066E-01

a. T = 4.2°K, 77°K, and 200°K. $\lambda < 24.1\mu$. (continued)

λ	ε	λ	ε	λ	ε
17.033	3.234E-01	17.350	3.575E-01	17.611	4.010E-01
17.897	4.650E-01	18.089	5.443E-01	18.144	5.650E-01
18.540	5.268E-01	18.951	6.835E-01	19.566	7.565E-01
19.752	6.408E-01	19.973	6.433E-01	20.157	5.594E-01
20.338	5.910E-01	20.437	6.415E-01	20.616	6.600E-01
20.753	5.554E-01	20.795	3.780E-01	20.803	2.033E-01
20.947	1.475E-01	21.243	9.600E-02	21.474	6.800E-02
21.540	5.925E-02	21.849	6.325E-02	22.270	9.425E-02
22.621	1.275E-01	22.997	1.280E-01	23.416	1.910E-01
23.749	2.202E-01	23.327	2.440E-01	24.007	2.949E-01

b. T = 4.2°K, $\lambda > 24\mu$.

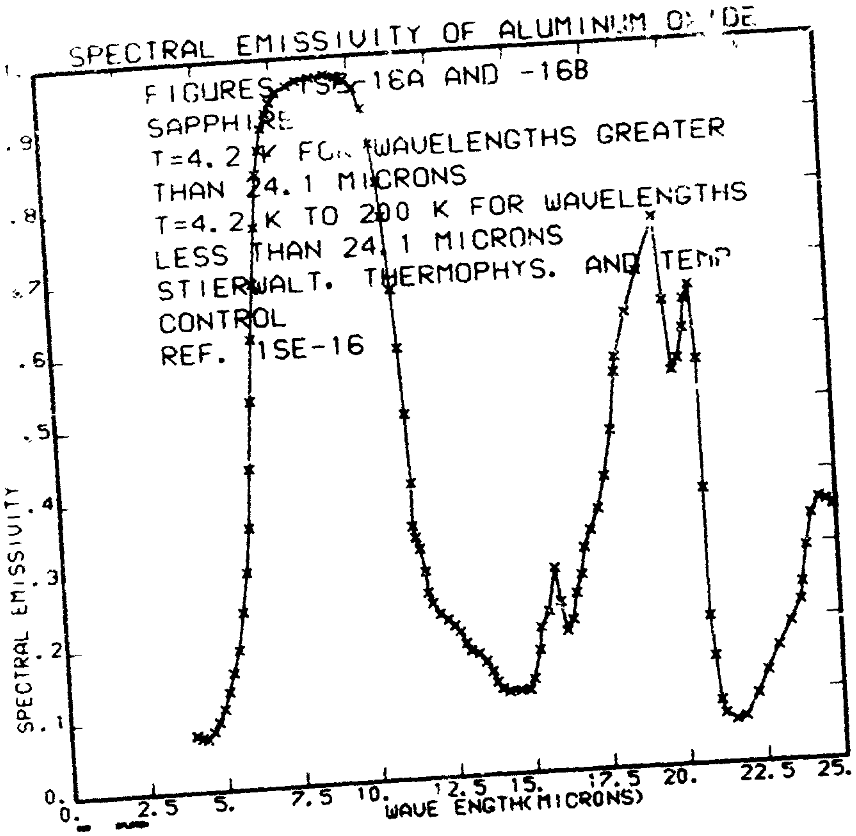
λ	ε	λ	ε	λ	ε
24.217	3.329E-01	24.473	3.591E-01	24.701	3.555E-01
24.9[illegible]	3.499E-01	25.283	3.611E-01	25.494	3.990E-01
25.559	4.237E-01	25.813	4.617E-01	26.229	4.851E-01
26.430	4.385E-01	26.715	4.252E-01	26.922	4.113E-01
27.038	3.400E-01	27.356	2.555E-01	27.795	1.955E-01
28.136	1.385E-01	28.785	1.549E-01	29.617	9.625E-02
30.934	7.150E-02	32.408	6.000E-02	34.460	4.975E-02
36.520	4.500E-02	39.940	4.050E-02	49.811	4.025E-02

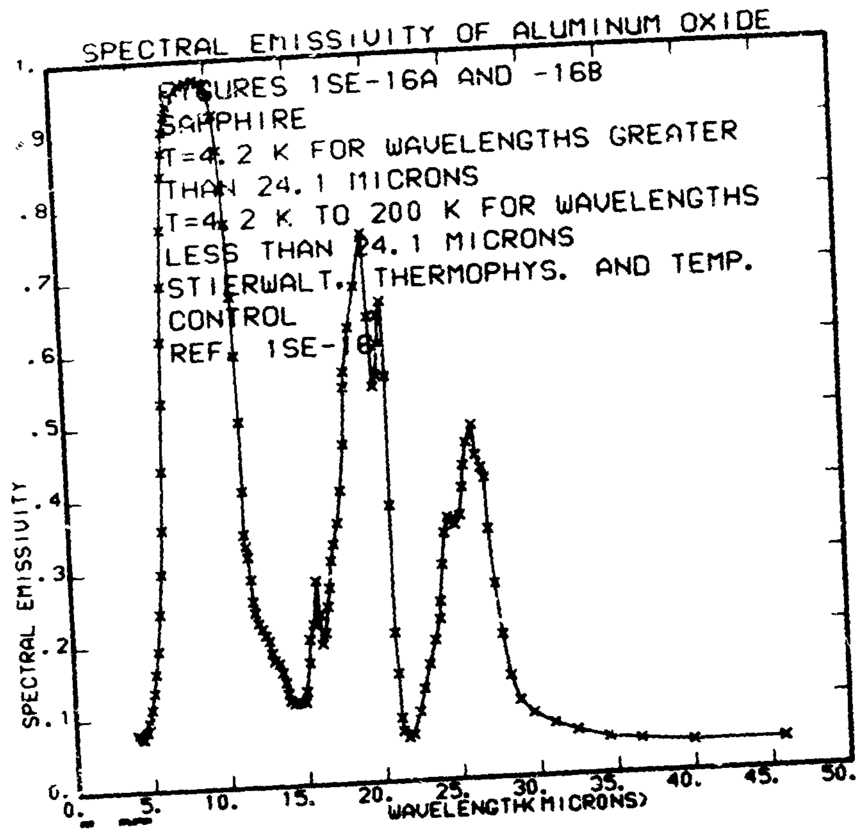
c. T = 77°K, $\lambda > 24\mu$.

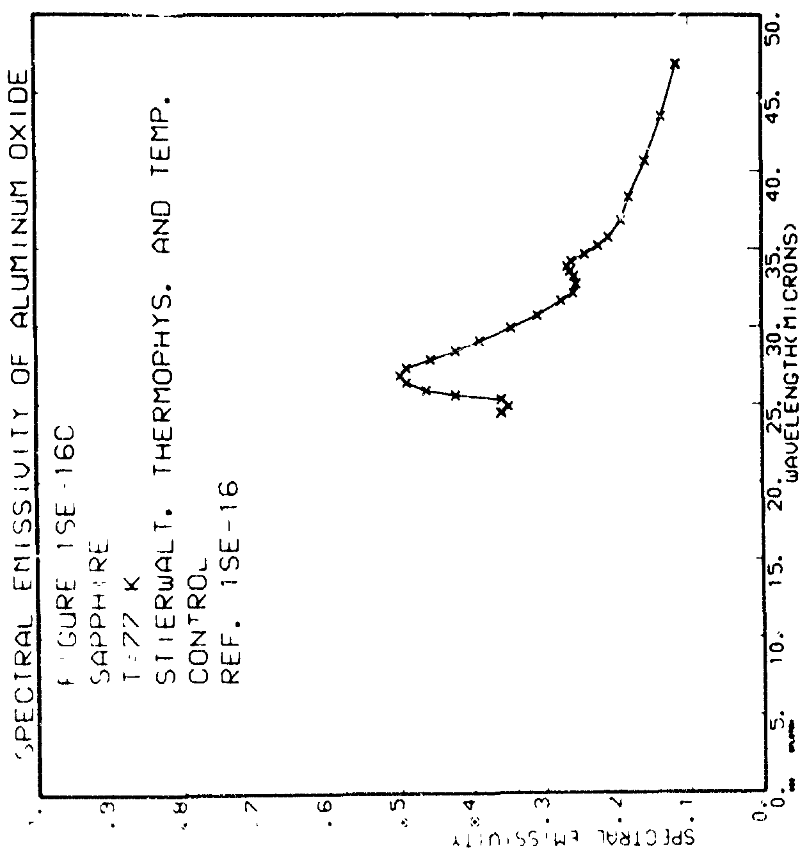
λ	ϵ	λ	ϵ	λ	ϵ
24.480	3.606E-01	24.873	3.504E-01	25.336	3.604E-01
25.562	4.234E-01	25.866	4.635E-01	26.362	4.914E-01
26.803	5.003E-01	27.316	4.909E-01	27.855	4.577E-01
28.397	4.237E-01	29.086	3.695E-01	29.917	3.466E-01
30.725	3.084E-01	31.677	2.760E-01	32.169	2.593E-01
32.756	2.555E-01	33.264	2.583E-01	33.564	2.639E-01
33.845	2.683E-01	34.244	2.621E-01	34.667	2.432E-01
35.221	2.258E-01	35.763	2.113E-01	36.894	1.937E-01
38.370	1.820E-01	40.663	1.608E-01	43.530	1.383E-01
46.359	1.178E-01	50.994	9.375E-02	55.448	7.950E-02
60.953	6.525E-02	67.441	5.050E-02	75.021	3.950E-02
82.261	3.325E-02	91.586	2.550E-02	99.467	2.175E-02
109.832	2.175E-02	124.927	2.050E-02		

d. T = 200°K, $\lambda > 24\mu$.

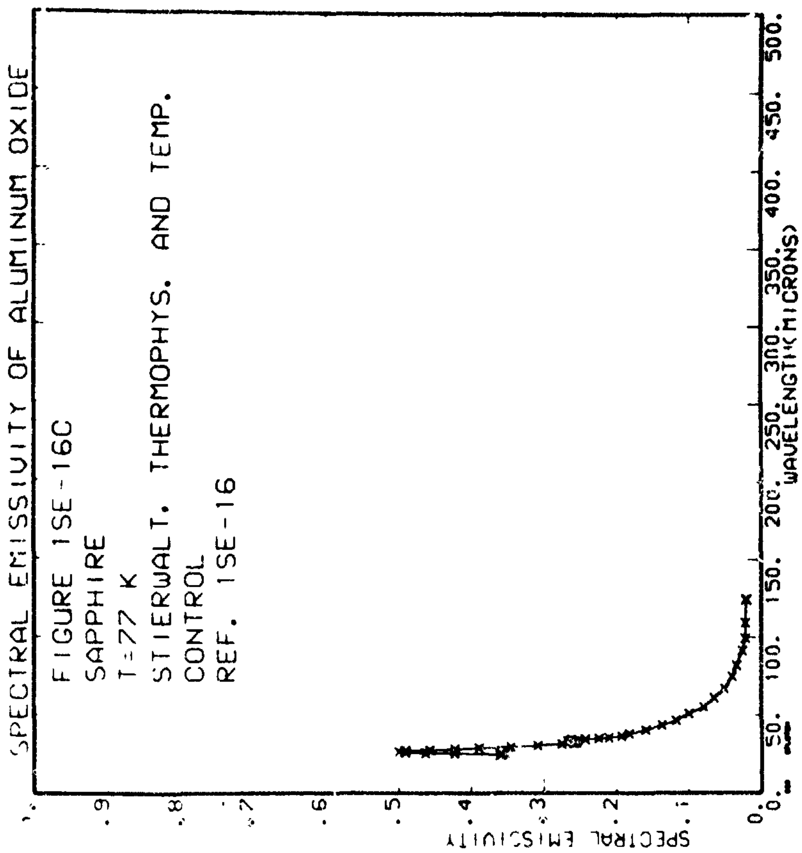
λ	ϵ	λ	ϵ	λ	ϵ
24.385	3.627E-01	24.955	3.323E-01	25.396	4.924E-01
25.653	5.257E-01	26.276	5.738E-01	27.316	6.135E-01
28.447	5.368E-01	30.426	6.630E-01	32.668	6.767E-01
34.959	5.812E-01	37.484	6.835E-01	40.496	6.835E-01
44.559	6.335E-01				


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURES 1SE-16A AND -16B
SAPPHIRE
T=4.2 K FOR WAVELENGTHS GREATER
THAN 24.1 MICRONS
T=4.2 K TO 200 K FOR WAVELENGTHS
LESS THAN 24.1 MICRONS
STIERWALT. THERMOPHYS. AND TEMP
CONTROL
REF. 1SE-16
SPECTRAL EMISSIVITY
WAVE ENGTH(MICRONS)

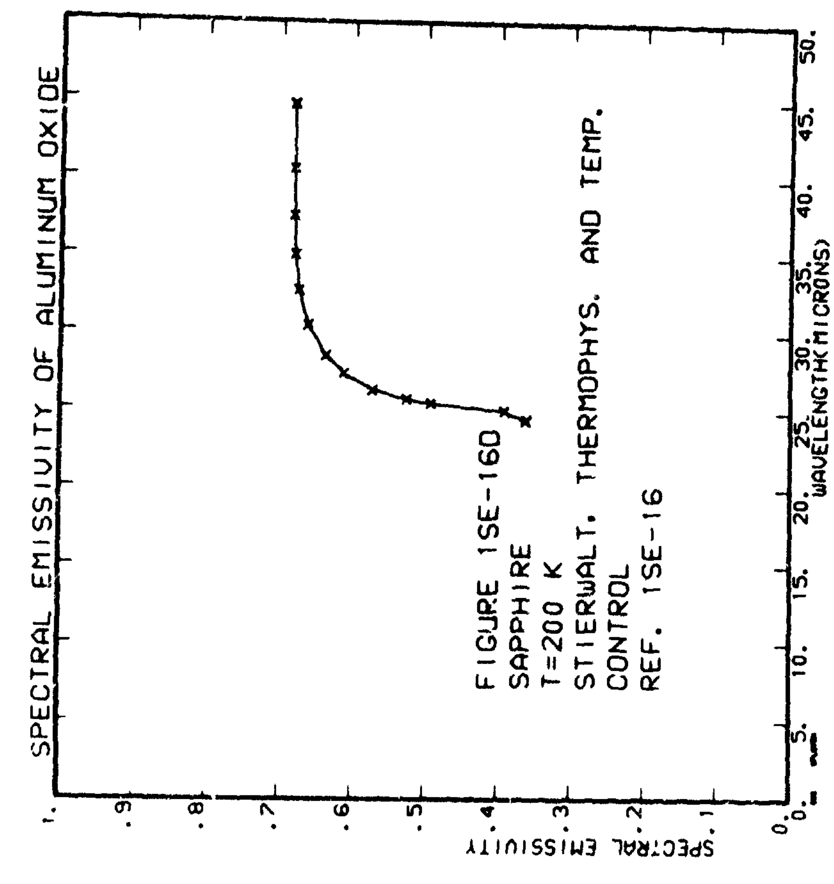

SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURES 1SE-16A AND -16B
SAPPHIRE
T=4.2 K FOR WAVELENGTHS GREATER
THAN 24.1 MICRONS
T=4.2 K TO 200 K FOR WAVELENGTHS
LESS THAN 24.1 MICRONS
STIERWALT. THERMOPHYS. AND TEMP.
CONTROL
REF. 1SE-16
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-16C
SAPPHIRE
T=77 K
STIERWALT. THERMOPHYS. AND TEMP.
CONTROL
REF. 1SE-16
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-16C
SAPPHIRE
T=77 K
STIERWALT. THERMOPHYS. AND TEMP.
CONTROL
REF. 1SE-16
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-16D
SAPPHIRE
T=200 K
STIERWALT. THERMOPHYS. AND TEMP.
CONTROL
REF. 1SE-16
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.

Streed (1SE-17)

Flame sprayed alumina particles of 99.95 purity were heated in a graphite tube furnace and studied using a KBr prism spectrometer with a bandwidth of 0.016 μ to 0.15 μ. Temperatures were measured using thermocouples and an optical pyrometer; sample substrates were estimated to be within 45°K of the nominal temperature. Particles of 0.06, 1.0 and 8.0 μ diameter were studied over a temperature range of 300°K to 2000°K. The peak at 3 μ is water associated. No error analysis was given. Data are digitized from lines.

These data are similar to the representative alumina powder data presented in Section 1-1.3.2.

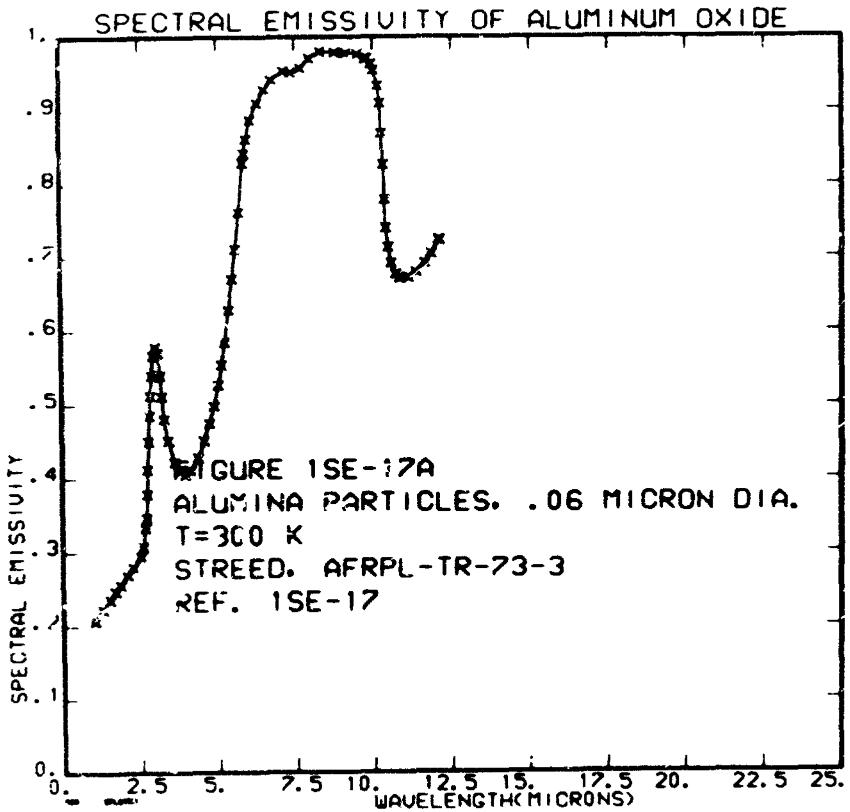
a. Particle size = .06 μ. T = 300°K.

λ	ε	λ	ε	λ	ε	λ	ε
1.206	.203	1.293	.223	1.564	.236	1.690	.247
1.957	.255	2.189	.266	2.272	.279	2.510	.294
2.531	.303	2.672	.332	2.700	.347	2.728	.379
2.742	.412	2.776	.451	2.816	.486	2.845	.514
2.889	.541	2.928	.567	3.000	.579	3.100	.571
3.152	.546	3.201	.513	3.206	.480	3.408	.451
3.568	.422	3.790	.411	3.960	.405	4.111	.411
4.357	.423	4.551	.451	4.743	.474	4.377	.499
5.019	.527	5.127	.555	5.243	.586	5.362	.628
5.465	.671	5.588	.712	5.701	.762	5.340	.829
5.475	.841	5.960	.851	6.090	.847	6.302	.909
6.525	.929	6.765	.942	7.155	.954	7.419	.952
7.793	.959	7.377	.971	8.541	.980	8.801	.980
8.156	.978	9.524	.973	9.753	.971	9.843	.971
9.954	.964	10.046	.956	10.149	.934	10.223	.909
10.261	.869	10.335	.826	10.374	.780	10.408	.741
10.461	.715	10.584	.696	10.745	.677	10.802	.672
11.165	.673	11.362	.681	11.661	.692	11.871	.706
12.128	.724						
13.366	.771	13.730	.771	14.213	.758	14.405	.767
14.567	.763	14.729	.770	15.215	.770	15.525	.768
15.784	.764	16.198	.756	16.581	.751	16.961	.745
17.382	.733	17.740	.731	18.214	.725	18.681	.725
19.202	.730	19.643	.735	20.194	.749	20.607	.757
21.175	.763	21.589	.772	21.919	.779		

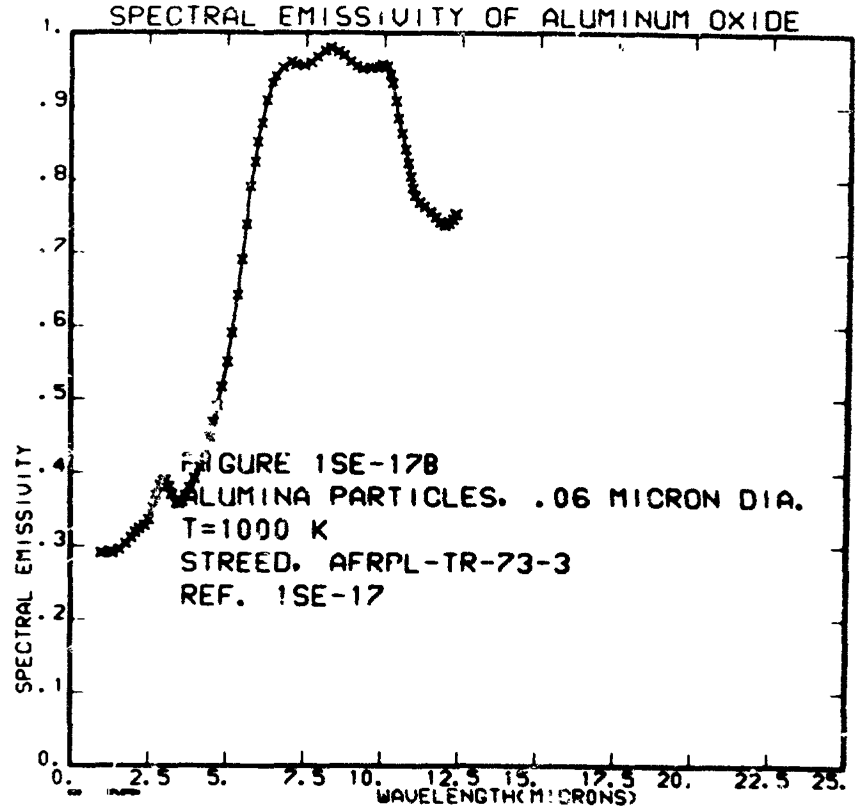
Streed (Ref. ISE-17)

b. Particle size = 0.06 μ. T = 1000°K

λ	ε	λ	ε	λ	ε	λ	ε
1.360	.291	1.295	.292	1.377	.291	1.577	.295
1.773	.303	1.954	.312	2.076	.316	2.218	.324
2.382	.327	2.522	.336	2.650	.353	2.769	.369
2.867	.383	2.976	.388	3.036	.390	3.149	.381
3.269	.371	3.416	.359	3.487	.356	3.578	.361
3.720	.368	3.843	.379	3.978	.392	4.150	.407
4.361	.427	4.456	.449	4.589	.468	4.721	.490
4.842	.518	5.016	.552	5.161	.592	5.340	.642
5.493	.692	5.510	.739	5.731	.791	5.879	.825
5.989	.851	6.111	.877	6.265	.908	6.428	.931
6.525	.941	6.765	.954	7.039	.961	7.163	.957
7.426	.956	7.656	.960	7.853	.968	8.121	.976
8.294	.930	8.527	.975	8.716	.970	8.903	.961
9.161	.955	9.292	.952	9.574	.953	9.771	.953
9.939	.958	10.084	.955	10.192	.944	10.272	.931
10.380	.887	10.457	.885	10.576	.863	10.682	.842
10.756	.823	10.861	.806	10.924	.789	11.007	.778
11.148	.770	11.321	.763	11.510	.757	11.650	.750
11.812	.742	11.967	.738	12.094	.741	12.222	.746
13.428	.776	13.717	.774	14.208	.776	14.623	.779
15.032	.784	15.501	.792	16.016	.797	16.581	.802
17.119	.804	17.422	.836	17.754	.812	18.126	.810
18.467	.792	18.965	.794	19.172	.784	19.381	.782
19.917	.782	20.529	.782	21.170	.781	21.686	.779



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-17A
ALUMINA PARTICLES. .06 MICRON DIA.
T=300 K
STREED. AFRPL-TR-73-3
REF. 1SE-17
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-17B
ALUMINA PARTICLES. .06 MICRON DIA.
T=1000 K
STREED. AFRPL-TR-73-3
REF. 1SE-17
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Streed (Ref. 1SE-17)

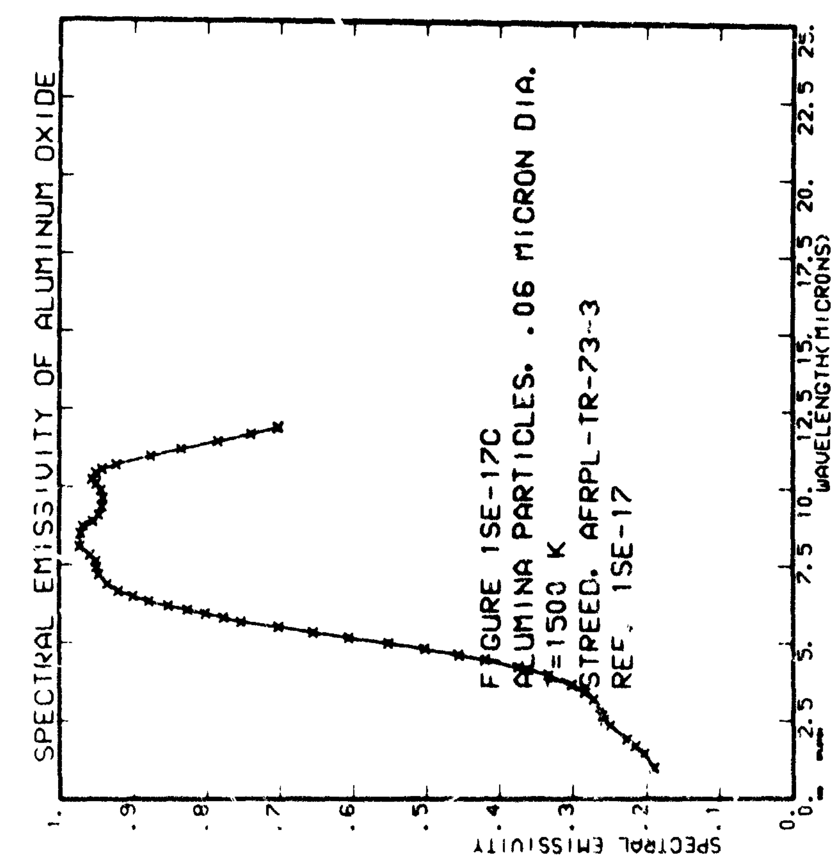
c. Particle size = 0.06 μ. T = 1500°K

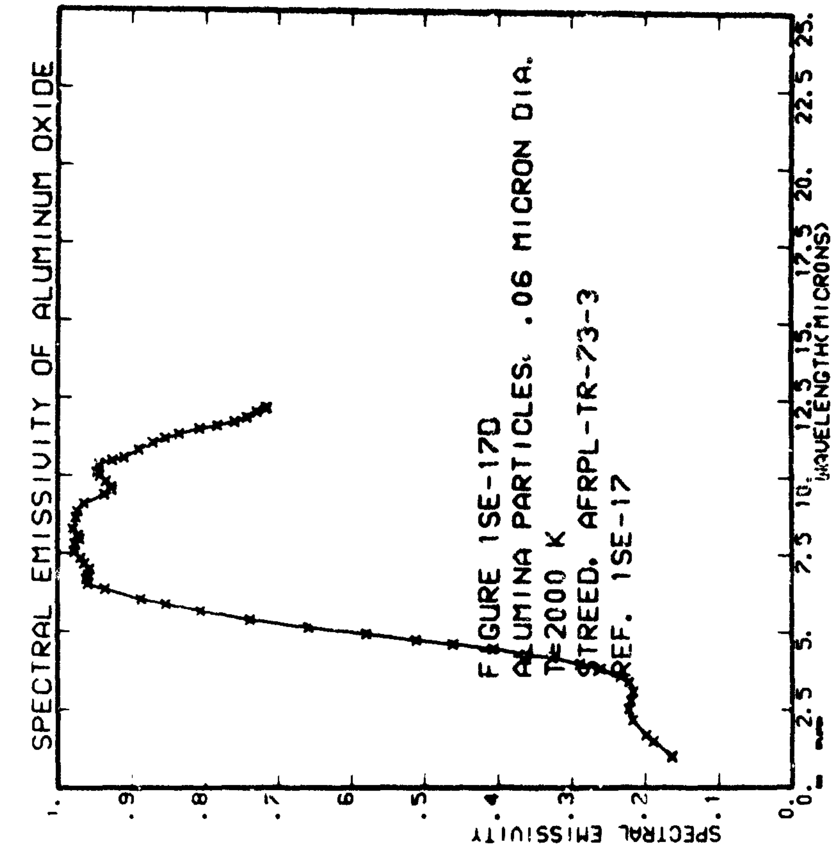
λ	ϵ	λ	ϵ	λ	ϵ	λ	ϵ
1.308	.189	1.467	.204	1.709	.215	1.923	.226
2.351	.248	2.523	.256	2.682	.260	2.956	.264
3.199	.273	3.431	.284	3.653	.302	3.975	.333
4.245	.375	4.470	.421	4.615	.455	4.810	.502
4.961	.552	5.158	.607	5.330	.655	5.500	.703
5.551	.754	5.816	.778	5.933	.902	6.054	.826
6.189	.852	6.328	.879	6.485	.902	6.651	.922
6.879	.936	7.160	.947	7.410	.951	7.599	.951
7.810	.959	8.097	.973	8.509	.971	8.741	.969
8.891	.956	9.093	.947	9.372	.943	9.628	.943
9.893	.945	10.186	.951	10.239	.956	10.428	.952
10.570	.943	10.704	.924	10.976	.877	11.220	.836
11.459	.785	11.687	.740	11.899	.733		
13.433	.634	13.897	.677	14.459	.670	14.942	.672
15.171	.653	15.725	.650	16.203	.642	16.479	.641
16.776	.645	17.250	.656	17.710	.676	18.158	.705
18.465	.729	18.630	.752	18.836	.780	19.140	.815
19.690	.842	20.194	.853	20.524	.849	20.822	.845
21.102	.832	21.361	.810	21.571	.794		

Streed (Ref. 1SE-17)

d. Particle size = 0.06 μ . T = 2000°K

λ	ε	λ	ε	λ	ε	λ	ε
1.003	.164	1.507	.188	1.715	.198	2.132	.217
2.534	.222	2.804	.220	3.119	.217	3.402	.222
3.594	.234	3.334	.231	3.964	.288	4.183	.327
4.292	.362	4.454	.407	4.616	.462	4.743	.513
4.940	.580	5.146	.659	5.379	.739	5.660	.808
5.873	.854	6.034	.888	6.349	.938	6.542	.960
6.681	.963	6.800	.959	7.012	.958	7.185	.965
7.351	.971	7.558	.979	7.802	.977	7.969	.971
8.097	.973	8.278	.981	8.656	.978	8.856	.975
9.116	.956	9.377	.959	9.530	.928	9.647	.929
9.900	.937	10.004	.945	10.100	.949	10.377	.945
10.473	.928	10.566	.912	10.828	.892	11.067	.873
11.201	.855	11.329	.836	11.503	.806	11.599	.785
11.747	.761	11.897	.744	12.057	.730	12.197	.717
13.463	.698	14.262	.689	14.726	.683	15.279	.675
15.300	.661	16.340	.654	16.712	.651	17.285	.647
17.633	.653	18.171	.675	18.481	.695	18.793	.717
19.100	.751	19.367	.771	19.701	.797	20.073	.803
20.453	.797	20.840	.789	21.175	.778	21.565	.766
21.780	.763	21.924	.759				


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
FIGURE 1SE-17C
ALUMINA PARTICLES. .06 MICRON DIA.
T=1500 K
STREED. AFRPL-TR-73-3
REF. 1SE-17


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
FIGURE 1SE-17D
ALUMINA PARTICLES. .06 MICRON DIA.
T=2000 K
STREED. AFRPL-TR-73-3
REF. 1SE-17

Streed (Ref. 1SE-17)

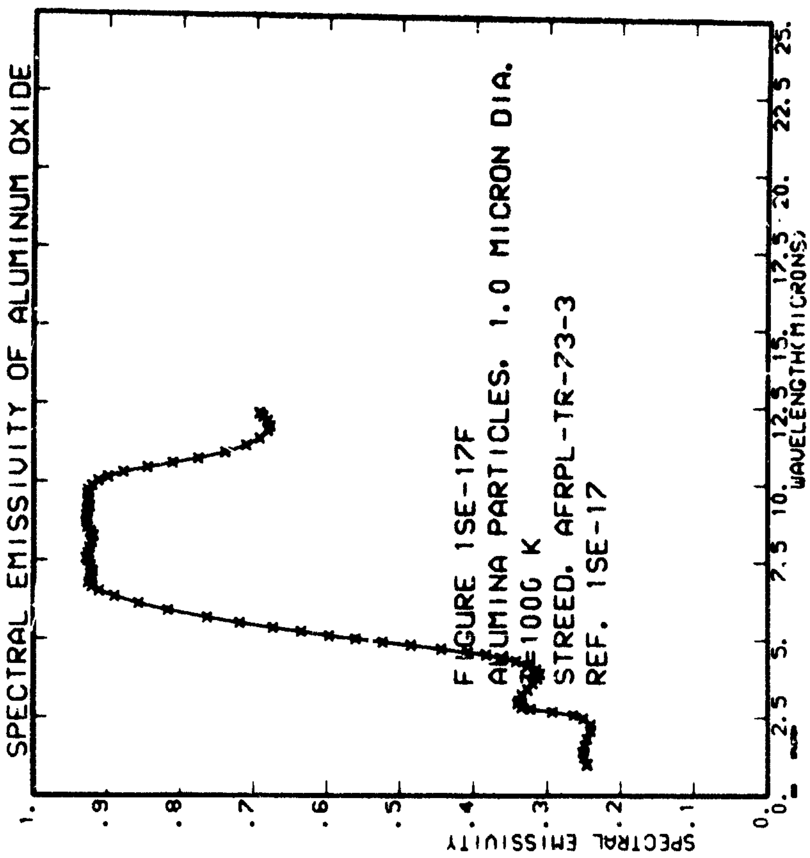
e. Particle size = 1.0μ. T = 300°K

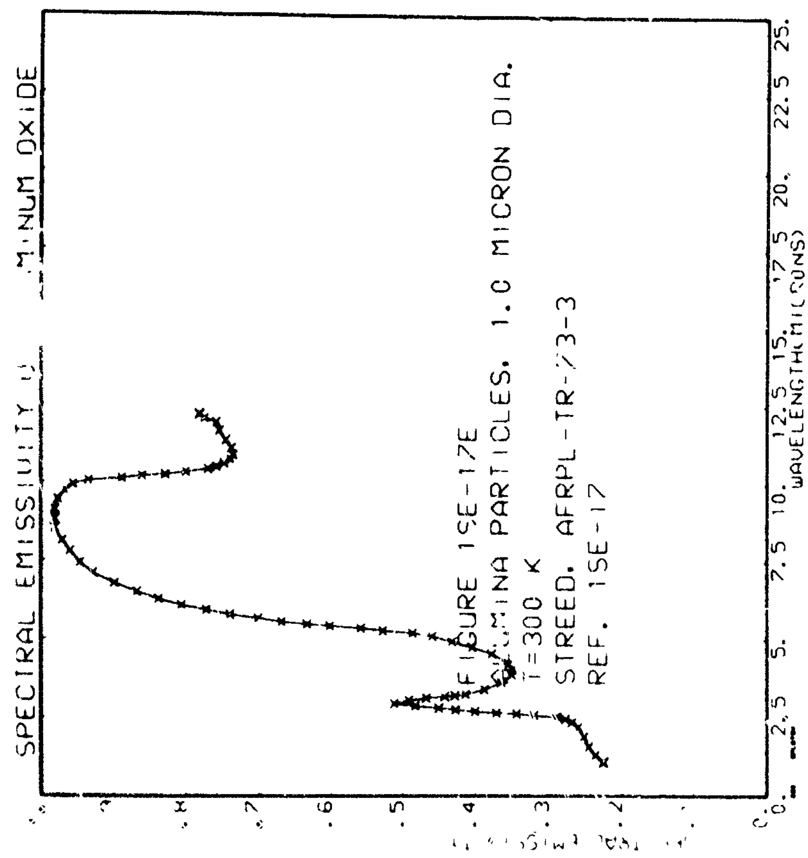
λ	ε	λ	ε	λ	ε	λ	ε
1.179	.225	1.364	.235	1.594	.245	1.901	.251
2.214	.269	2.349	.268	2.449	.277	2.527	.290
2.587	.319	2.630	.345	2.666	.372	2.715	.402
2.764	.429	2.811	.452	2.882	.484	2.958	.514
3.061	.492	3.129	.469	3.189	.444	3.215	.429
3.266	.415	3.420	.388	3.624	.365	3.887	.351
4.362	.350	4.234	.355	4.555	.378	4.768	.405
4.938	.434	5.100	.400	5.212	.488	5.294	.529
5.352	.560	5.426	.602	5.497	.634	5.571	.669
5.654	.732	5.794	.743	5.937	.773	6.096	.808
6.283	.838	6.503	.866	6.777	.900	7.104	.928
7.447	.946	7.812	.960	8.147	.971	8.523	.982
8.923	.981	9.137	.981	9.456	.977	9.744	.967
9.336	.957	10.049	.934	10.142	.889	10.212	.862
10.271	.838	10.341	.802	10.427			
10.602	.747	10.726	.738	10.877	.735	11.104	.737
11.350	.745	11.600	.754	11.930	.759	12.070	.775
12.177	.782						
13.714	.814	14.207	.810	14.582	.811	15.188	.814
15.607	.814	15.221	.807	16.513	.800	17.101	.789
17.452	.789	17.745	.790	18.147	.793	18.537	.797
19.118	.835	19.599	.815	20.066	.824	20.356	.827
20.648	.829	21.461	.832	21.933	.835		

Streed (Ref. 1SE-17)

f. Particle size = 1.0 μ. T = 1000°K

λ	ε	λ	ε	λ	ε	λ	ε
1.101	.245	1.242	.249	1.414	.251	1.598	.249
1.846	.246	2.091	.241	2.292	.240	2.490	.250
2.590	.255	2.692	.293	2.774	.322	2.840	.335
2.952	.318	3.169	.339	3.229	.335	3.412	.326
3.605	.319	3.759	.313	3.906	.310	4.029	.315
4.157	.327	4.313	.342	4.406	.363	4.509	.383
4.581	.419	4.603	.445	4.798	.486	4.904	.524
5.201	.551	5.115	.598	5.247	.636	5.363	.674
5.516	.719	5.981	.764	5.911	.817	6.139	.857
6.371	.890	6.547	.911	6.653	.921	6.789	.926
6.920	.923	7.067	.921	7.161	.921	7.326	.924
7.460	.926	7.530	.930	7.747	.927	7.901	.924
8.084	.921	8.273	.920	8.414	.923	8.564	.927
8.731	.928	8.929	.928	9.087	.928	9.214	.924
9.418	.926	9.515	.926	9.744	.925	9.889	.920
10.034	.912	10.155	.899	10.302	.879	10.464	.845
10.682	.911	10.763	.776	10.963	.739	11.188	.711
11.419	.593	11.553	.632	11.808	.679	11.980	.682
12.128	.681	12.220	.694	14.283	.732	14.473	.736
13.696	.728	14.043	.729	15.007	.739	15.442	.737
14.594	.741	14.793	.742	16.247	.721	16.641	.719
15.575	.728	15.888	.724	17.001	.739	17.785	.746
17.029	.721	17.359	.727	18.516	.739	18.799	.729
17.987	.750	18.238	.746	19.674	.701	19.877	.698
19.072	.714	19.340	.708	20.562	.728	20.817	.743
20.139	.703	20.319	.714	21.451	.748	21.719	.745
21.074	.750	21.240	.751				
21.914	.742						


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-17F
ALUMINA PARTICLES. 1.0 MICRON DIA.
T=1000 K
STREED. AFRPL-TR-73-3
REF. 1SE-17
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.


SPECTRAL EMISSIVITY
MINUM OXIDE
FIGURE 1SE-17E
T=300 K
STREED. AFRPL-TR-73-3
REF. 1SE-17
WAVELENGTH(MICRONS)
2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0. .2 .3 .4 .5 .6 .7 .8

Streed (Ref. 1SE-17)

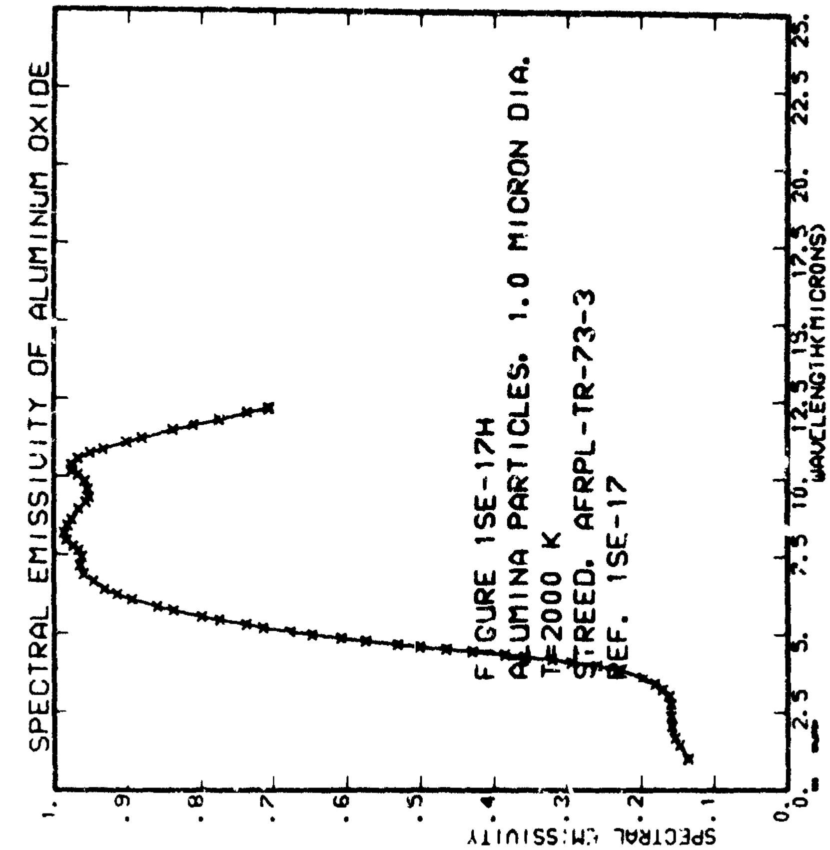
g. Particle size = 1.0 μ. T = 1500°K

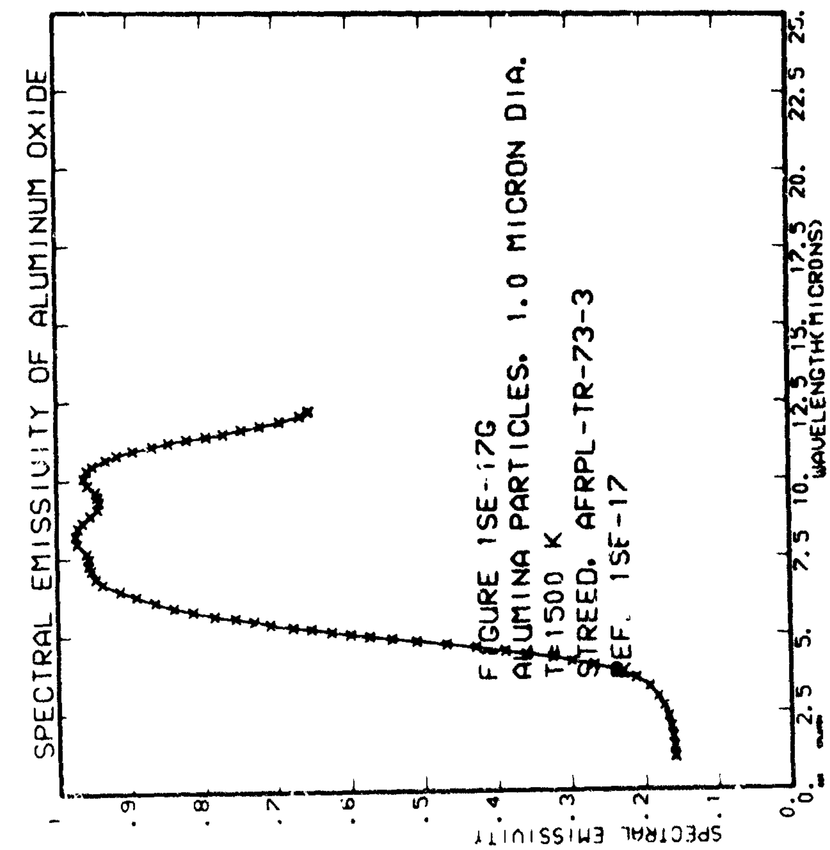
λ	ε	λ	ε	λ	ε	λ	ε
1.850	.158	1.405	.159	1.710	.161	2.044	.163
2.365	.167	2.712	.174	3.015	.182	3.339	.194
3.615	.211	3.371	.237	4.028	.268	4.166	.299
4.282	.325	4.376	.360	4.487	.389	4.613	.429
4.714	.470	4.813	.511	4.885	.545	4.965	.574
5.026	.601	5.121	.627	5.199	.654	5.268	.679
5.37[illegible]	.712	5.457	.733	5.550	.757	5.644	.786
5.783	.816	5.819	.841	6.092	.868	6.290	.893
6.470	.914	6.677	.939	6.869	.948	7.142	.954
7.294	.957	7.507	.958	7.683	.961	7.939	.972
8.243	.974	8.488	.972	8.658	.965	8.875	.955
9.076	.946	9.312	.944	9.475	.945	9.645	.947
9.853	.950	10.390	.963	10.326	.959	10.472	.953
10.569	.935	10.810	.918	10.903	.896	11.096	.870
11.204	.847	11.298	.822	11.397	.797	11.493	.773
11.675	.747	11.711	.722	11.856	.695	12.043	.668
12.184	.656						
13.696	.629	14.254	.617	14.758	.615	15.322	.606
15.717	.594	16.154	.581	16.628	.585	17.077	.595
17.508	.615	17.891	.635	18.236	.664	18.537	.693
18.717	.713	18.917	.737	19.091	.761	19.278	.786
19.513	.809	19.381	.826	20.359	.839	20.945	.830
21.256	.904	21.502	.735	21.743	.759	21.871	.732
21.909	.712						

Streed (Ref. 1SE-17)

h. Particle size = 1.0 μ. T = 2000^{o}K

λ	ϵ	λ	ϵ	λ	ϵ	λ	ϵ
1.007	.135	1.469	.148	1.695	.154	2.070	.157
2.378	.159	2.779	.158	3.031	.161	3.229	.171
3.406	.180	3.605	.197	3.860	.231	3.987	.260
4.084	.295	4.191	.322	4.270	.358	4.337	.385
4.428	.430	4.562	.465	4.588	.502	4.668	.532
4.766	.575	4.853	.609	4.961	.648	5.053	.679
5.183	.714	5.278	.739	5.430	.774	5.543	.799
5.740	.838	5.967	.860	6.084	.894	6.223	.914
6.422	.933	6.656	.948	6.884	.960	7.163	.965
7.423	.964	7.655	.967	7.782	.974	7.969	.984
8.181	.936	8.428	.952	8.636	.977	8.953	.968
9.193	.959	9.341	.954	9.578	.955	9.872	.959
10.043	.969	10.164	.977	10.392	.977	10.575	.968
10.761	.953	10.831	.935	11.108	.903	11.238	.882
11.501	.938	11.663	.812	11.334	.775	12.051	.738
12.209	.797						
13.642	.676	13.947	.681	14.360	.677	14.913	.663
15.298	.650	15.348	.635	16.348	.620	16.835	.615
17.134	.620	17.535	.631	17.859	.649	18.091	.665
18.428	.633	18.717	.737	18.914	.756	19.163	.791
19.393	.812	19.722	.835	20.195	.846	20.434	.848
20.753	.846	21.205	.831	21.454	.812	21.649	.790
21.821	.773	21.922	.759				


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-17H
ALUMINA PARTICLES. 1.0 MICRON DIA.
T=2000 K
STREED. AFRPL-TR-73-3
REF. 1SE-17
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-17G
ALUMINA PARTICLES. 1.0 MICRON DIA.
T=1500 K
STREED. AFRPL-TR-73-3
REF. 1SE-17
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.

Streed (Ref. 1SE-17)

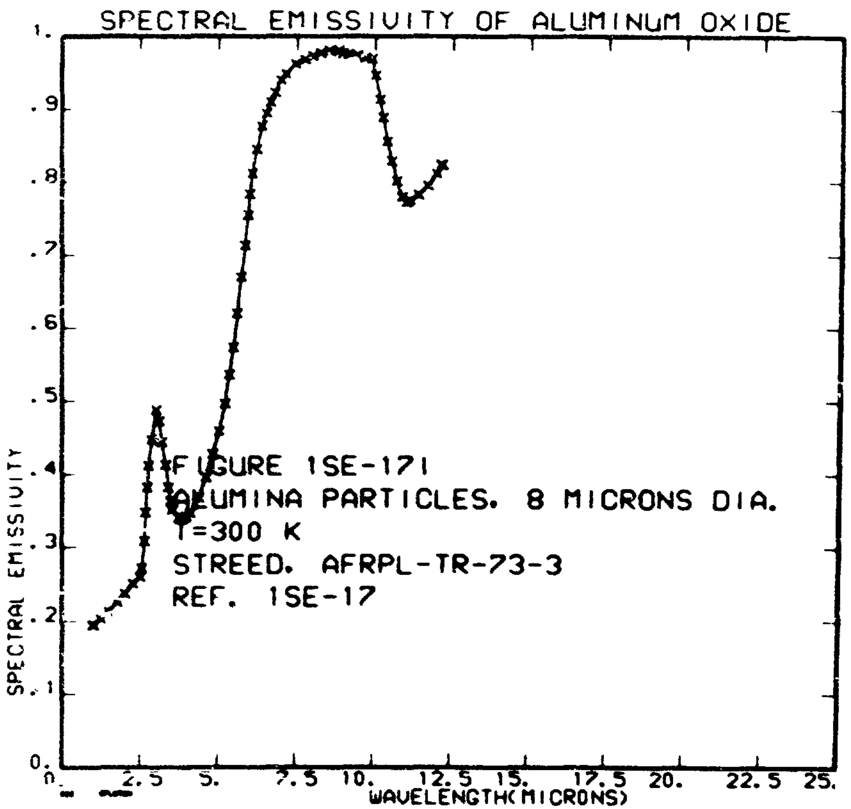
i. Particle size = 8.0 μ . T = 300°K

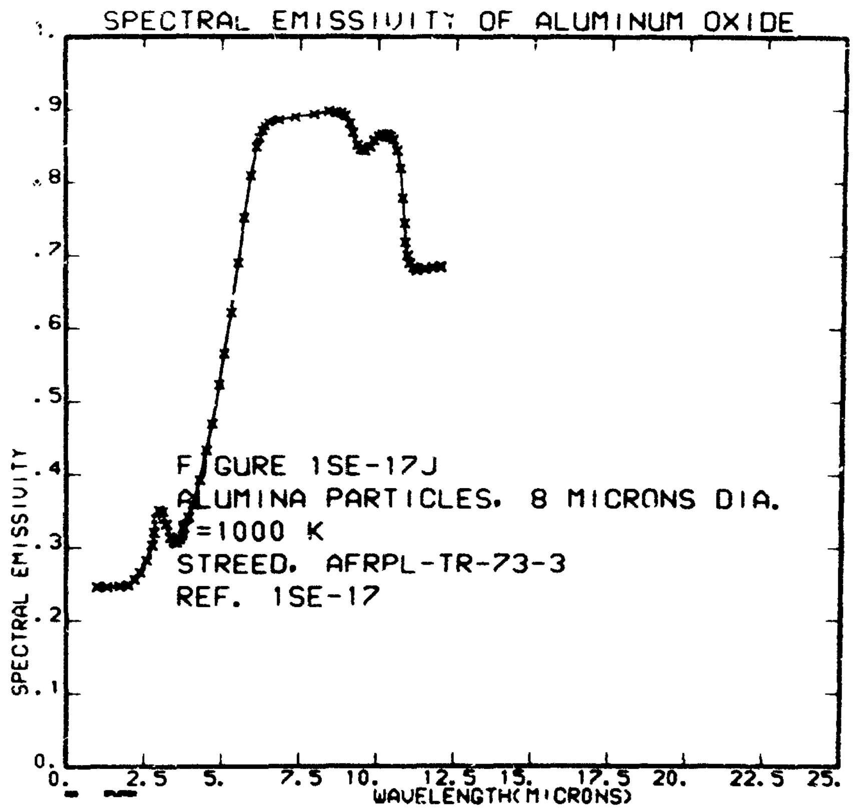
λ	ε	λ	ε	λ	ε	λ	ε
1.001	.194	1.258	.204	1.517	.212	1.794	.225
2.032	.236	2.297	.251	2.503	.259	2.557	.273
2.658	.309	2.686	.348	2.726	.382	2.790	.412
2.975	.448	3.005	.488	3.100	.474	3.218	.444
3.324	.414	3.419	.383	3.483	.363	3.544	.352
3.750	.342	3.976	.342	4.106	.347	4.373	.369
4.616	.397	4.838	.429	5.028	.459	5.210	.497
5.356	.537	5.479	.575	5.620	.622	5.746	.671
5.853	.714	5.952	.755	6.011	.784	6.080	.813
6.229	.846	6.396	.877	6.523	.895	6.663	.911
6.306	.923	7.004	.941	7.154	.950	7.471	.963
7.758	.970	8.313	.974	8.271	.978	8.545	.982
8.327	.932	8.971	.978	9.136	.977	9.427	.975
9.590	.972	9.918	.970	10.044	.948	10.164	.915
10.268	.890	10.412	.857	10.553	.829	10.711	.802
10.877	.781	11.026	.774	11.143	.775	11.410	.784
11.703	.736	11.397	.813	12.154	.825		
13.507	.855	14.248	.852	14.716	.849	15.220	.846
15.774	.843	16.268	.840	16.728	.836	17.203	.834
17.713	.834	18.249	.836	18.719	.839	19.219	.845
19.683	.857	20.220	.867	20.691	.874	21.276	.878
21.724	.883						

Streed (Ref. 1SE-17)

j. Particle size = 8.0 μ. T = 1000°K

λ	ε	λ	ε	λ	ε	λ	ε
1.903	.246	1.346	.246	1.730	.246	2.012	[illegible]
2.217	.255	2.391	.206	2.586	.293	2.763	.304
2.842	.320	2.912	.340	2.991	.352	3.106	.350
3.241	.332	3.368	.313	3.464	.308	3.541	.306
3.526	.312	3.797	.326	3.935	.341	4.077	.359
4.292	.332	4.505	.434	4.685	.469	4.907	.523
5.071	.567	5.286	.622	5.515	.690	5.713	.753
5.921	.810	6.102	.850	6.191	.863	6.275	.872
6.363	.879	6.491	.883	6.815	.886	7.334	.890
7.931	.894	8.416	.899	8.636	.897	8.818	.897
8.931	.832	9.074	.861	9.190	.868	9.336	.851
9.437	.845	9.550	.845	9.732	.850	9.852	.858
10.004	.853	10.144	.866	10.275	.866	10.379	.863
10.483	.859	10.500	.844	10.702	.821	10.795	.779
10.864	.746	10.871	.719	10.923	.701	11.001	.690
11.143	.614	11.237	.681	11.506	.683	11.753	.684
11.999	.685						
13.765	.720	13.979	.718	14.165	.724	14.368	.735
14.660	.737	14.892	.734	15.047	.732	15.246	.727
15.462	.728	15.575	.734	15.944	.738	16.242	.738
16.523	.734	16.338	.729	17.098	.724	17.342	.726
17.522	.729	17.723	.733	17.989	.731	18.285	.728
18.536	.724	18.826	.721	19.104	.719	19.297	.726
19.467	.735	19.680	.750	19.914	.765	20.062	.774
20.255	.775	20.420	.773	20.631	.771	20.797	.768
20.976	.764	21.184	.764	21.336	.766	21.501	.768
21.580	.773	21.851	.773	21.986	.782		


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-17I
ALUMINA PARTICLES. 8 MICRONS DIA.
T=300 K
STREED. AFRPL-TR-73-3
REF. 1SE-17
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-17J
ALUMINA PARTICLES. 8 MICRONS DIA.
T=1000 K
STREED. AFRPL-TR-73-3
REF. 1SE-17
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0.
.1
.2
.3
.4
.5
.6
.7
.8
.9
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

Streed (Ref. 1SE-17)

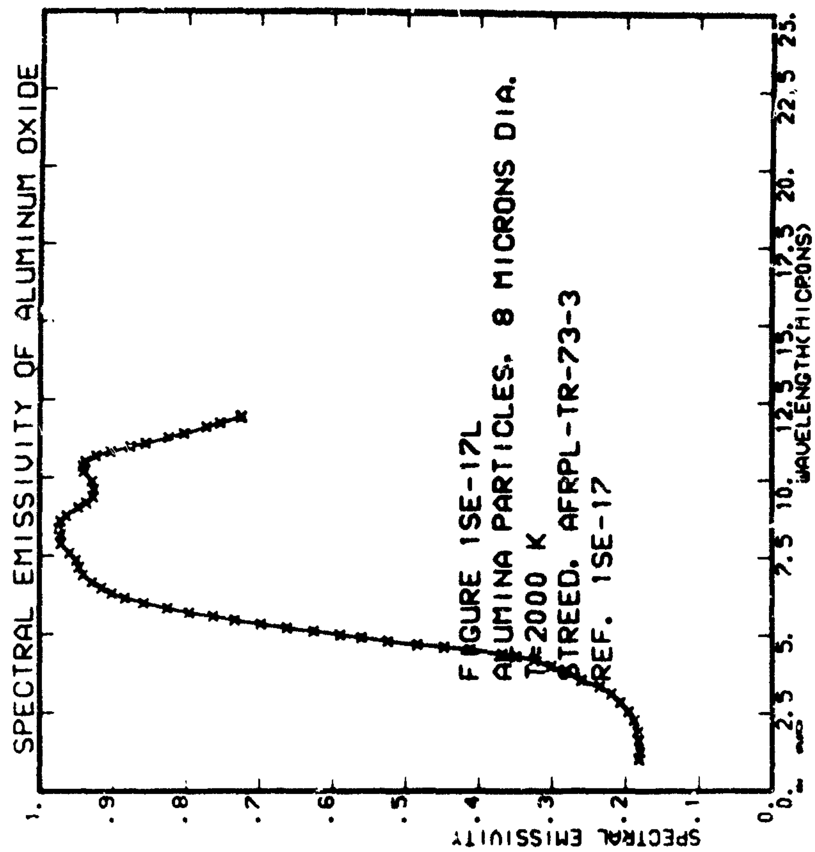
k. Particle size = 8.0 μ. T = 1500°K

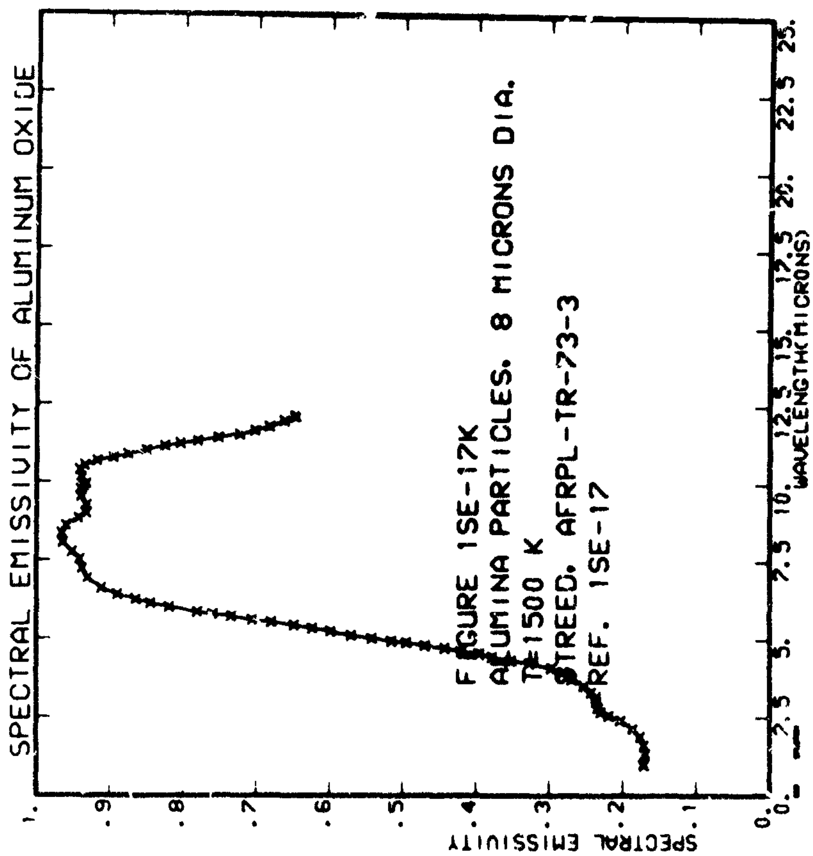
λ	ε	λ	ε	λ	ε	λ	ε
1.001	.172	1.352	.169	1.640	.171	1.904	.177
2.170	.187	2.411	.204	2.568	.219	2.682	.230
2.818	.235	3.067	.236	3.164	.236	3.320	.243
3.516	.253	3.745	.269	3.967	.280	4.086	.297
4.234	.327	4.322	.352	4.437	.378	4.532	.396
4.618	.420	4.709	.443	4.787	.470	4.873	.496
4.950	.516	5.019	.543	5.112	.571	5.231	.599
5.333	.624	5.437	.649	5.536	.680	5.615	.706
5.702	.735	5.774	.760	5.868	.782	6.022	.821
6.144	.845	6.268	.866	6.411	.890	6.613	.913
6.946	.931	7.237	.938	7.545	.942	7.756	.953
8.059	.965	8.354	.966	8.603	.951	8.830	.943
9.020	.933	9.262	.933	9.536	.940	9.759	.941
9.396	.937	9.972	.933	10.157	.939	10.374	.941
10.534	.936	10.678	.919	10.788	.896	10.883	.877
11.031	.952	11.146	.827	11.229	.805	11.332	.782
11.437	.753	11.547	.725	11.657	.704	11.792	.683
11.953	.664	12.105	.649				
13.750	.665	13.941	.663	14.221	.656	14.397	.646
14.711	.639	15.198	.630	15.611	.622	15.992	.618
16.293	.620	16.671	.628	17.117	.640	17.393	.649
17.686	.663	18.242	.689	18.400	.707	18.670	.733
18.951	.756	19.222	.788	19.491	.376	19.766	.824
20.314	.835	20.770	.828	21.176	.811	21.444	.797
21.732	.791	21.916	.764				

Streed (Ref. 1SE-17)

1. Particle size = 8.0 μ . T = 2000°K

λ	ε	λ	ε	λ	ε	λ	ε
1.027	.182	1.254	.180	1.044	.183	1.902	.184
2.274	.188	2.557	.197	2.855	.207	3.124	.220
3.354	.235	3.563	.260	3.828	.281	4.016	.302
4.201	.323	4.314	.349	4.384	.368	4.525	.412
4.600	.448	4.692	.484	4.793	.526	4.900	.561
4.991	.591	5.098	.626	5.213	.664	5.334	.699
5.456	.735	5.576	.763	5.693	.796	5.837	.826
6.001	.858	6.167	.835	6.311	.902	6.473	.916
6.650	.929	6.896	.941	7.139	.947	7.369	.951
7.593	.961	7.888	.972	8.173	.972	8.371	.974
8.608	.973	8.779	.965	9.034	.948	9.192	.937
9.386	.929	9.626	.927	9.888	.929	10.188	.940
10.349	.941	10.498	.939	10.703	.924	10.823	.904
10.955	.878	11.108	.856	11.285	.826	11.422	.805
11.533	.774	11.772	.755	11.955	.727		
13.782	.634	14.226	.681	14.708	.675	15.201	.672
15.725	.654	16.129	.636	16.443	.637	16.827	.645
17.197	.656	17.745	.662	18.159	.665	18.471	.671
18.767	.689	19.128	.718	19.279	.737	19.524	.763
19.855	.801	20.233	.812	20.531	.807	20.835	.794
21.274	.781	21.669	.763	21.859	.756		


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-17L
ALUMINA PARTICLES. 8 MICRONS DIA.
T=2000 K
STREED. AFRPL-TR-73-3
REF. 1SE-17
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-17K
ALUMINA PARTICLES. 8 MICRONS DIA.
T=1500 K
STREED. AFRPL-TR-73-3
REF. 1SE-17
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Touloukian (Ref. 1SE-18)

a. The spectral emissivity of General Electric Lucalox, a cold-pressed and sintered alumina with MgO added to control grain growth is presented for material of unspecified purity. The sample surface is machined, and the temperature is 813°K. Precision is ± 5 percent. These data show a much higher $\epsilon(\lambda)$ than the representative curve given in Section I, Figure I-1.3.1, and were digitized from discrete points.

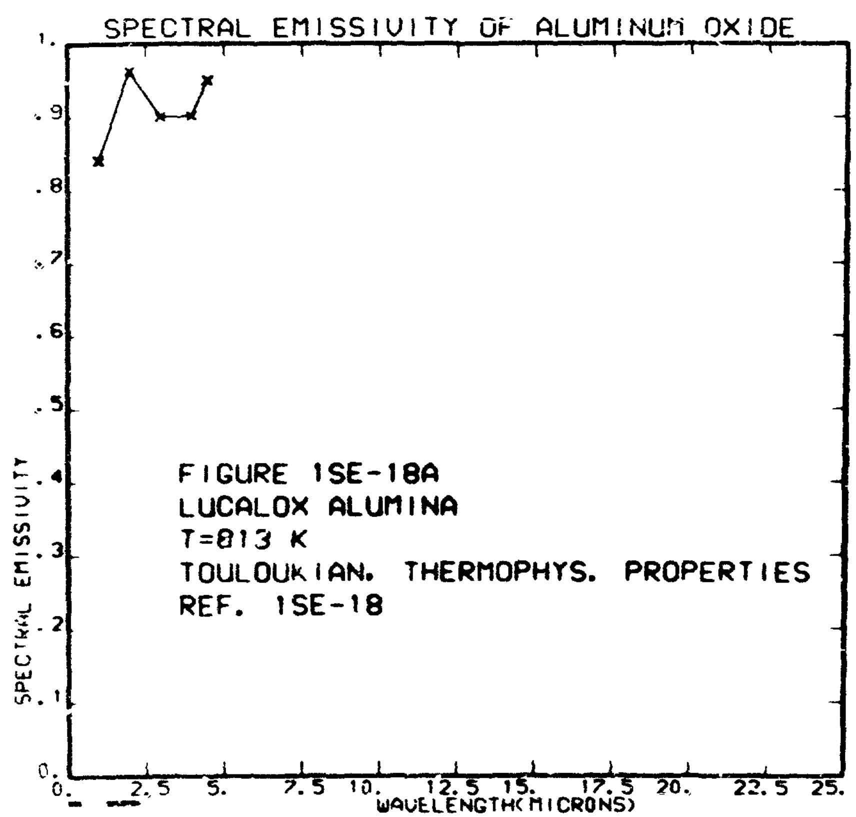
λ	ϵ	λ	ϵ	λ	ϵ	λ	ϵ
1.031	.841	1.983	.963	2.975	.901	3.975	.903
4.43[illegible]	.951						

b. Measurements of the spectral emissivity of Norton TWA, No. 2 alumina is presented. The alumina was machined ultrasonically and given a diamond wheel finish and had a purity of 98.56 percent. A precision of ± 4 percent is claimed. The temperature is 1323°K. These data are in good agreement with the representative curve given in Section I-1.3, and were digitized from discrete points.

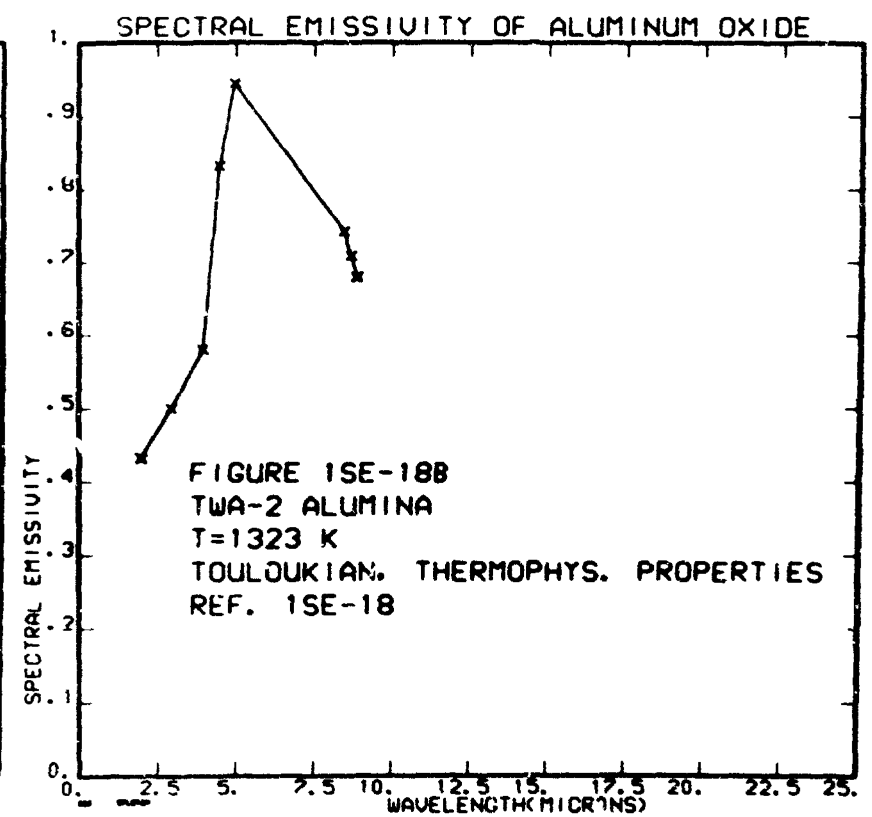
λ	ϵ	λ	ϵ	λ	ϵ	λ	ϵ
1.985	.432	2.970	.5[illegible]0	3.955	.580	4.484	.633
4.966	.944	9.449	.742	8.683	.709	8.978	.680

c. Same as (b) above, but the temperature is 873°K.

λ	ϵ	λ	ϵ	λ	ϵ	λ	ϵ
1.987	.370	3.962	.439	4.495	.729	4.964	.940
5.465	.902	5.945	.929	5.850	.930	7.866	.941
8.214	.833	9.703	.627				



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-18A
LUCALOX ALUMINA
T=813 K
TOULOUKIAN. THERMOPHYS. PROPERTIES
REF. 1SE-18
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)



SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-18B
TWA-2 ALUMINA
T=1323 K
TOULOUKIAN. THERMOPHYS. PROPERTIES
REF. 1SE-18
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)

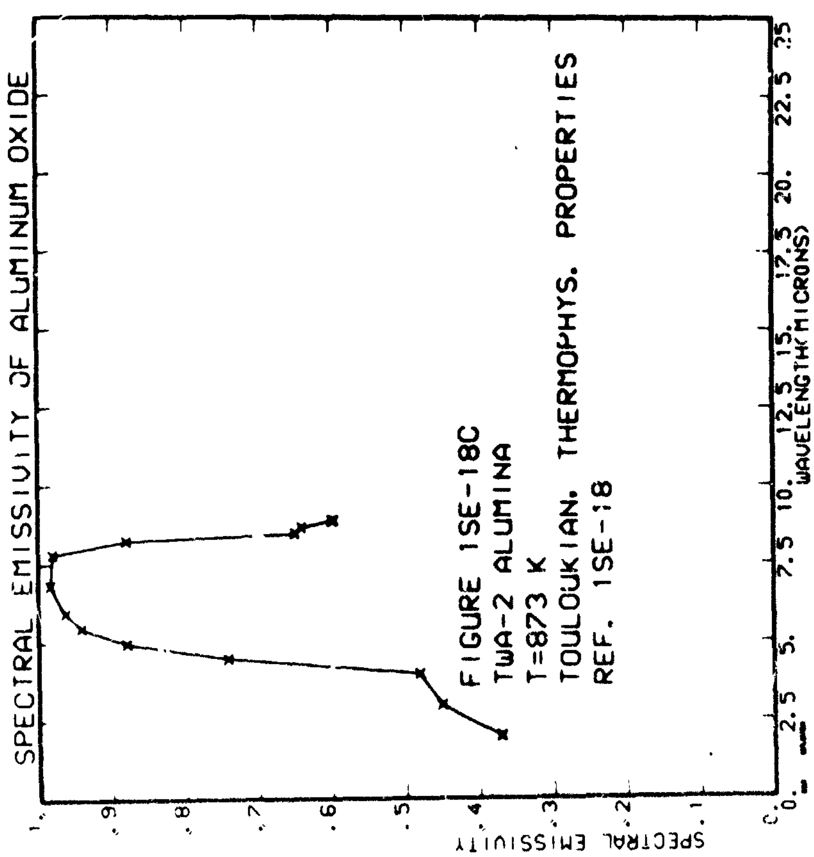
Touloukian (Ref. 1SE-18)

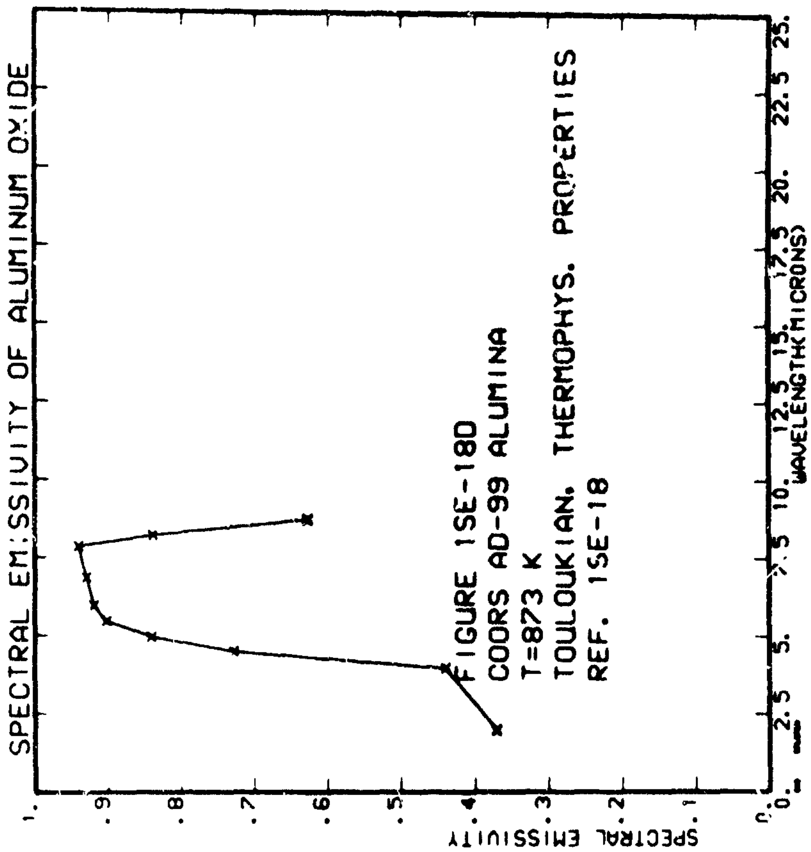
d. Coors AD-99 alumina, 99 percent pure Al_2O_3, machined ultrasonically with a diamond wheel finish was studied using unspecified techniques. A precision of ± 4 percent is claimed. The temperature is 873°K. These data are in good agreement with the representative curve given in Section I-1.3, and were digitized from discrete points.

λ	ε	λ	ε	λ	ε	λ	ε
1.998	.370	2.981	.451	3.980	.481	4.496	.742
4.948	.881	5.464	.342	5.940	.963	6.825	.983
7.309	.980	9.224	.380	8.461	.650	8.664	.541
8.987	.599						

e. Coors AD-995 alumina, 99.5 percent pure Al_2O_3, machined surface was studied using unspecified techniques. A precision of ± 5 percent is claimed. The temperature is 814°K. These data show ε(λ) much lower at 3μ than the representative curve given in Section I, Figure I-1.3, and were digitized from discrete points.

λ	ε	λ	ε	λ	ε	λ	ε
1.002	.543	1.981	.271	3.005	.201	3.384	.310
4.201	.691						

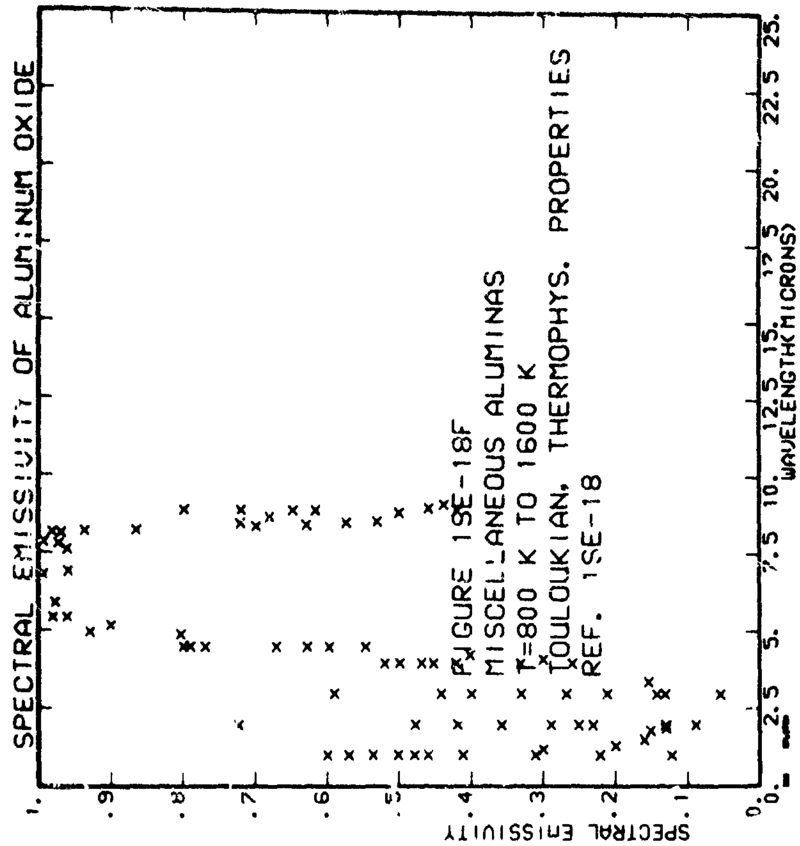

SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-18C
TWA-2 ALUMINA
T=873 K
TOULOUKIAN. THERMOPHYS. PROPERTIES
REF. 1SE-18
SPECTRAL EMISSIVITY
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25

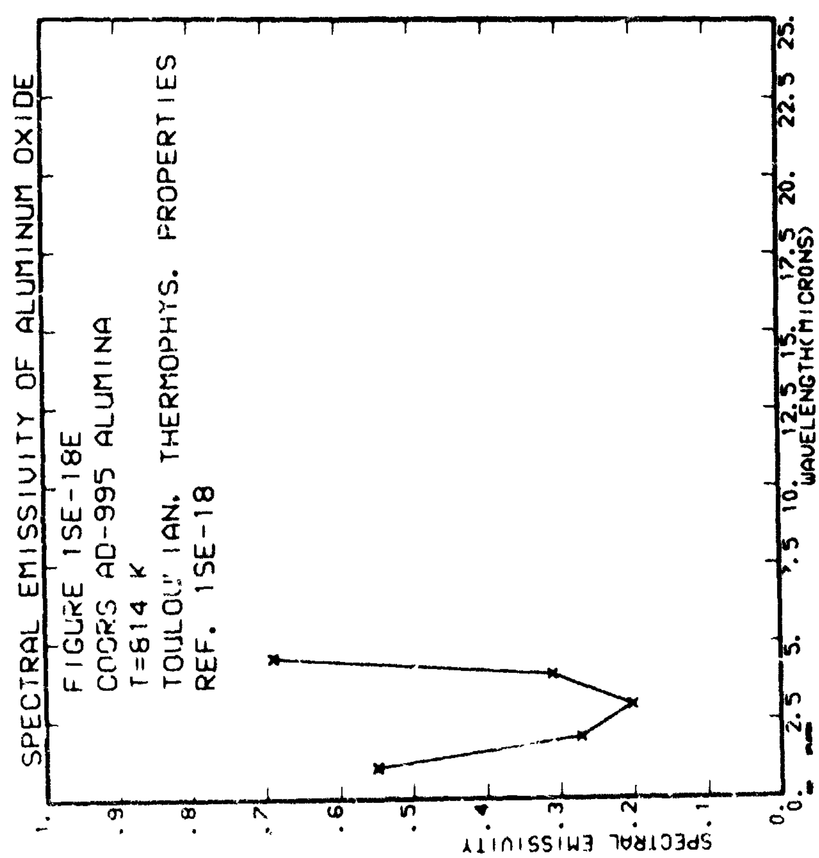

SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-18D
COORS AD-99 ALUMINA
T=873 K
TOULOUKIAN. THERMOPHYS. PROPERTIES
REF. 1SE-18
SPECTRAL EMISSIVITY
0. .1 .2 .3 .4 .5 .6 .7 .8 .9 1.
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Toulcukian (Ref. 1SE-18)

f, These are the remaining materials of Ref. 1SE-18, including Coors AD-99, Coors AD-96, Coors AD 96 + 1 $CoCO_3$, McDanel AP-30 (99 percent), McDanel AV30, vitrified alumina (96 percent), and McDanel AP-35 (isostatic)(99 percent). Precision is ±5 percent in general, and the temperature ranges from 800°K to 1600°K. These data were digitized from distinct points, and show good agreement with the representative curve for $\lambda < 3\,\mu$. For $\lambda > 3\,\mu$ there is a large variation within the data.

λ	ε	λ	ε	λ	ε	λ	ε
1.001	.599	1.001	.569	1.001	.536	1.001	.501
1.001	.478	1.001	.459	1.001	.412	1.001	.310
1.001	[illegible]	1.001	.122	1.173	.300	1.299	.199
1.498	[illegible]	1.806	.151	1.896	.134	1.986	.723
[illegible]	.473	1.985	.418	1.996	.358	1.986	.288
[illegible]	.250	1.986	.230	1.986	.129	1.986	.088
[illegible]	.590	2.979	.440	2.979	.399	2.979	.330
2.979	.267	2.979	.211	2.979	.142	2.979	.130
2.979	[illegible]	3.391	.153	3.970	.519	3.970	.499
3.970	.463	3.970	.452	3.970	.420	3.970	.331
[illegible]	.259	4.094	.299	4.228	.401	4.493	.799
4.493	.791	4.493	.779	4.493	.670	4.493	.626
4.493	.593	4.493	.547	4.881	.802	4.958	.930
[illegible]	.900	5.436	.990	5.436	.951	5.919	.977
[illegible]	.394	5.910	.959	7.615	.962	7.821	.972
[illegible]	.393	8.155	.959	8.196	.981	8.204	.937
[illegible]	[illegible]	8.357	.599	8.438	.629	8.459	.720
8.478	.573	8.529	.531	8.569	.679	8.300	.500
[illegible]	.799	8.894	.719	8.894	.647	8.894	.617
8.894	.419	8.959	.459	9.097	.437		


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-18F
MISCELLANEOUS ALUMINAS
T=800 K TO 1600 K
TOULOUKIAN, THERMOPHYS. PROPERTIES
REF. 1SE-18
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)


SPECTRAL EMISSIVITY OF ALUMINUM OXIDE
FIGURE 1SE-18E
COORS AD-995 ALUMINA
T=814 K
TOULOUKIAN, THERMOPHYS. PROPERTIES
REF. 1SE-18
SPECTRAL EMISSIVITY
WAVELENGTH(MICRONS)

Section III-1.4 Tabulated Total Emissivity Data - Aluminum Oxide

Contents:

Gannon (Ref. ITE-1)

The emittance of Norton Co. E111 alumina as a function of porosity and roughness was studied using a thermistor bolometer and a blackbody furnace. Samples were prepared by cold-pressing and sintering at 1973°K. Measurements were made between 958°K and 1158°K. No error analysis was given. Data were taken from a table.

The values measured for $\epsilon(T)$ are considerably lower than the representative curve given in Section I - 1.4.

Porosity (percent)	ϵ_n (958°K $\leq T \leq$ 1158°K)
9.7	0.34
14.0	0.37
19.0	0.34
23.0	0.35
30.0	0.35

Surface Roughness	(Center Line Average)
< 20 μ inch	0.35
> 20 μ inch	0.36

Mergerian (Ref. 1TE-2)

Measurements of the total integrated (1 μ to 13 μ) emissivity of synthetic sapphire from T = 373°K to 1273°K were made using a Perkin-Elmer Model 99, NaCl monochromator and a blackbody furnace. No estimates of precision are given. These data are approximately 0.1 higher than Wittenberg's (Ref. 1TE-6) at 373°K, where they overlap. No representative curve was constructed for sapphire, and all measured total emissivities for sapphire are lower than the representative curve for alumina given in Section I - 1.4.

T	ϵ	T	ϵ	T	ϵ	T	ϵ
358.420	.460	645.358	.489	1012.585	.545	1269.627	.577

Morizumi (Ref TE-3)

The emissivity of rocket engine exhaust particles ranging from 0.79 μ to 3.95 μ in diameter was measured using narrow angle radiometers, black surfaced asymptotic calorimeters, and scanning spectrometers. It is concluded that ε (T) for small alumina particles is comparable to bulk alumina instead of sapphire. No error analysis was given. Data are digitized from distinct points. Sample temperature ranged from T = 1389°K to 2222°K. These data show emissivities slightly lower than the representative alumina curve given in Section I - 1.4.

a. Small rocket, expansion ratio 19:1 and exhaust diameter 12 in., measured by radiometer.

T	ε	T	ε	T	ε	T	ε
1984.319	.175	1985.397	.155	2058.609	.116	2152.558	.195
2152.558	.245						

b. Large rocket, expansion ratio 23.5:1 and exit diameter 26 in., measured by radiometer.

T	ε	T	ε	T	ε	T	ε
1677.041	.222	1677.041	.183	1762.335	.244	1884.234	.251
1937.430	.251						

c. Same rocket as b., measured by spectrometer.

T	ε
1481.226	.235

Olson (Ref. 1TE-4)

ε(T) was measured for Norton RA-4213 alumina and LA-603 alumina in air. Experimental details were not given. These data were digitized from curves.

These points were selected together with data from Ref. 1TE-5, to construct the representative curve given in Section I, Figure I - 1.4.

a. Norton RA-4213

T	ε	T	ε	T	ε	T	ε
224.685	.703	63.709	.776	81.217	.764	174.917	.749
397.313	.617	255.651	.790	318.678	.651	369.490	.665
547.561	.565	435.448	.671	523.554	.538	529.417	.558
764.531	.510	597.329	.533	743.734	.482	751.046	.523
1373.437	.395	775.742	.488	800.114	.408	1049.006	.407
1656.130	.313	1376.423	.335	1496.028	.381	1519.252	.290
		1714.156	.331	1781.353	.325		

b. Norton LA-603

T	ε	T	ε	T	ε	T	ε
390.336	.735	168.109	.773	203.287	.773	328.775	.741
524.368	.639	406.622	.700	432.353	.698	520.297	.658
699.365	.622	563.058	.624	563.058	.609	610.989	.625
1068.364	.516	761.444	.568	779.992	.635	783.541	.567
1470.481	.441	1304.783	.506	1312.716	.519	1364.147	.536
		1472.472	.459	1678.314	.426		

Touloukian (Ref. 1TE-5)

Various aluminas were studied, including Norton 603 and RA-4213. Measurements were made in air, argon, and vacuum. No error analysis was given. These data were digitized from specific points, and were selected together with data from Ref. 1T-4, to construct the representative curve given in Section I, Figure I - 1.4.

T	ε	T	ε	T	ε	T	ε
53.488	.725	67.001	.700	327.044	.779	359.245	.769
419.676	.768	427.646	.753	467.740	.763	496.638	.704
531.258	.783	598.007	.659	606.053	.741	645.145	.665
657.755	.712	662.547	.616	637.011	.700	693.317	.678
705.170	.670	767.213	.650	784.368	.536	787.390	.631
799.155	.695	791.173	.667	805.473	.649	831.095	.547
861.692	.616	864.677	.630	869.154	.573	885.323	.615
923.632	.614	946.259	.360	946.259	.349	950.498	.338
962.169	.630	968.159	.287	999.502	.482	1006.023	.531
1019.322	.565	1025.345	.510	1039.147	.569	1040.402	.386
1040.652	.432	1060.226	.635	1064.994	.570	1069.762	.408
1095.358	.253	1137.767	.510	1144.793	.356	1144.793	.349
1149.306	.338	1163.112	.467	1169.887	.248	1204.569	.525
1220.558	.420	1223.934	.249	1243.401	.483	1264.467	.337
1328.426	.509	1339.340	.519	1363.452	.545	1360.406	.445
1366.497	.263	1384.264	.393	1385.279	.329	1472.976	.941
1480.946	.449	1487.920	.462	1433.649	.376	1499.875	.277
1524.533	.285	1569.614	.277	1657.649	.433	1660.936	.307
1677.623	.283	1722.630	.330	1743.869	.450	1784.071	.322

Wittenberg (Ref. 1TE-6)

A calorimetric measurement was made of $\epsilon(T)$ for polished sapphire with the C-axis perpendicular and parallel to the surface normal. An error analysis indicates a relative accuracy of ± 1.5 percent and an absolute accuracy of ± 3.0 percent. These data were digitized from points. At $373^{\circ}K$, where these data overlap measurements made by Mergerian (Ref. 1TE-2), they show $\epsilon(T)$ being approximately 0.1 lower than Mergerian's. No representative curve for sapphire was constructed. All measured values for $\epsilon(T)$ of sapphire are lower than the representative curve for alumina given in Section I - 1.4.

a. C axis parallel to the sample surface

T	ε	T	ε	T	ε	T	ε
204.631	.496	205.346	.503	216.123	.503	226.484	.500
244.485	.504	254.248	.518	270.658	.523	295.645	.536
313.744	.543	325.367	.549	337.091	.555	354.801	.562
371.250	.565	373.369	.568				

b. C axis perpendicular to the sample surface

T	ε	T	ε	T	ε	T	ε
210.055	.474	212.551	.471	235.141	.479	240.452	.487
256.507	.496	269.393	.504	296.892	.524	320.456	.533
322.484	.534	322.822	.531	338.236	.541	370.893	.552
371.395	.550						

III-1.5 Tabulated Reflectivity Data - Aluminum Oxide

Contents:

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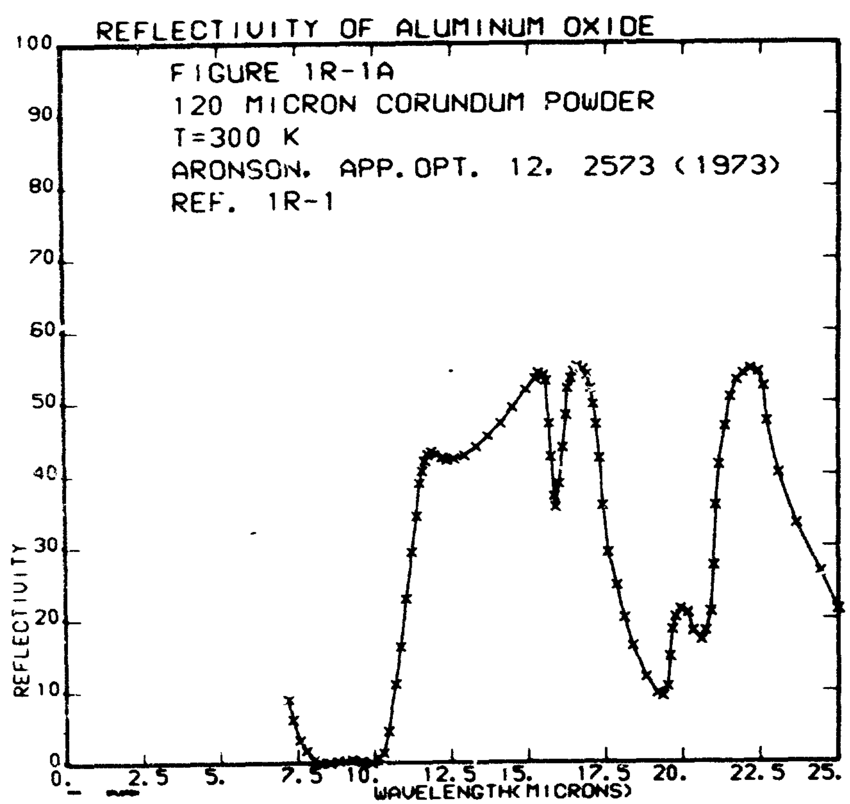
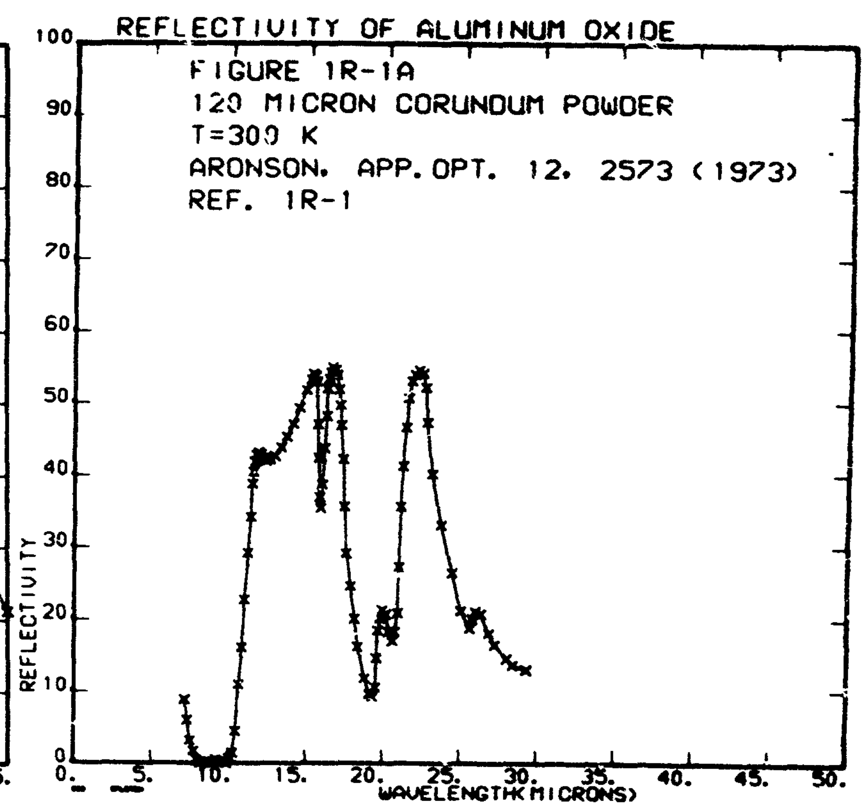
Aronson (Ref. 1R-1)

i) The reflectivity of corundum powders of irregular shape has been measured using a Michaelson interferometer. Powder size ranges from 0.3μ to 120μ in average diameter. No spectral bandpass or error analysis is given. The temperature is approximately 300°K. Data were digitized from lines. These data were used to construct the representative curve given in Section I, Figure I-1.5.3.

a. Particle size = 120μ diameter. Supplied by Norton Co.

λ	R	λ	R	λ	R
7.198	6.864E+00	7.354	6.074E+00	7.589	3.244E+00
7.835	1.777E+00	8.039	4.752E-01	8.216	8.264E-02
8.565	4.132E-02	8.827	2.273E-01	9.277	4.752E-01
9.012	2.479E-01	9.916	2.066E-02	10.137	5.992E-01
10.306	1.467E+00	10.462	4.504E+00	10.688	1.105E+01
10.858	1.615E+01	11.034	2.273E+01	11.216	2.925E+01
11.355	3.424E+01	11.456	3.880E+01	11.527	4.056E+01
11.527	4.190E+01	11.733	4.281E+01	11.861	4.315E+01
12.038	4.281E+01	12.217	4.232E+01	12.343	4.206E+01
12.575	4.228E+01	12.923	4.251E+01	13.314	4.383E+01
13.591	4.539E+01	14.090	4.719E+01	14.476	4.932E+01
14.898	5.182E+01	15.206	5.337E+01	15.322	5.409E+01
15.493	5.383E+01	15.570	5.299E+01	15.555	4.705E+01
15.734	4.246E+01	15.829	3.697E+01	15.876	3.546E+01
15.993	3.672E+01	16.101	4.371E+01	15.211	4.826E+01
16.205	5.200E+01	16.348	5.341E+01	15.458	5.431E+01
16.539	5.505E+01	16.760	5.463E+01	16.876	5.389E+01
17.013	5.194E+01	17.100	4.970E+01	17.192	4.695E+01
17.309	4.224E+01	17.419	3.554E+01	17.573	2.919E+01
17.848	2.462E+01	18.105	2.016E+01	18.377	1.528E+01
18.799	1.198E+01	19.188	9.628E+00	19.352	9.194E+00
19.501	1.006E+01	19.582	1.471E+01	19.667	1.851E+01
19.759	2.025E+01	19.940	2.138E+01	20.154	2.084E+01
20.347	1.635E+01	20.521	1.700E+01	20.741	1.837E+01
20.911	2.094E+01	20.982	2.731E+01	21.148	3.566E+01
21.150	4.135E+01	21.355	4.657E+01	21.544	5.074E+01
21.742	5.315E+01	21.938	5.407E+01	22.193	5.461E+01
22.437	5.425E+01	22.606	5.226E+01	22.714	4.733E+01
23.393	4.020E+01	23.664	3.318E+01	24.424	2.650E+01
25.000	2.124E+01	25.529	1.888E+01	25.756	2.014E+01
25.952	2.110E+01	26.319	2.084E+01	26.855	1.814E+01
27.248	1.655E+01	27.997	1.461E+01	28.415	1.372E+01
29.339	1.314E+01				

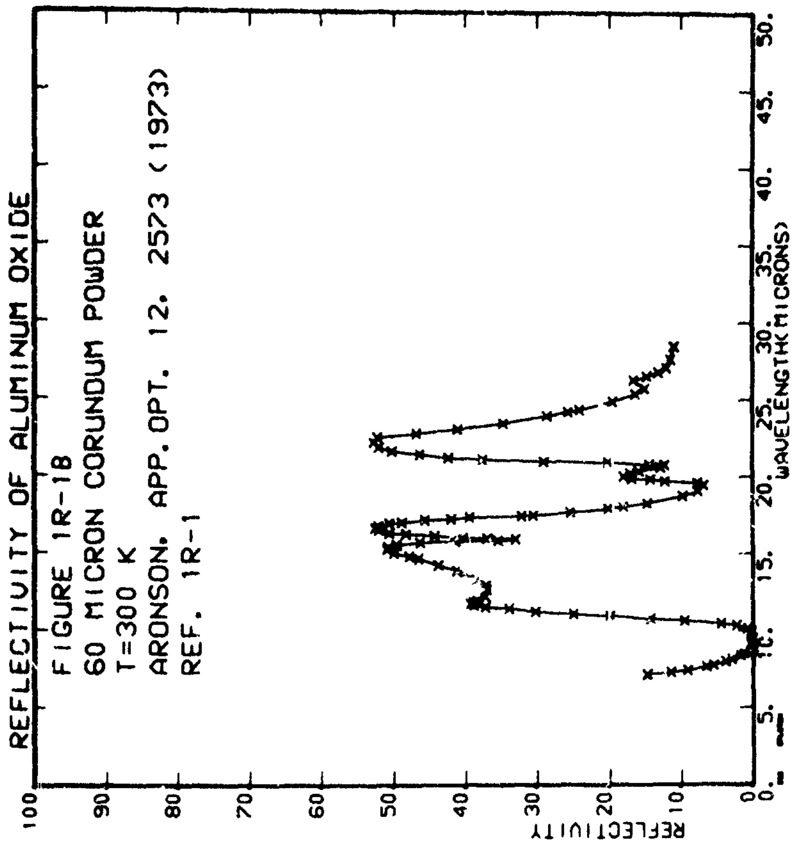

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1A
120 MICRON CORUNDUM POWDER
T=300 K
ARONSON. APP.OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1A
120 MICRON CORUNDUM POWDER
T=300 K
ARONSON. APP.OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

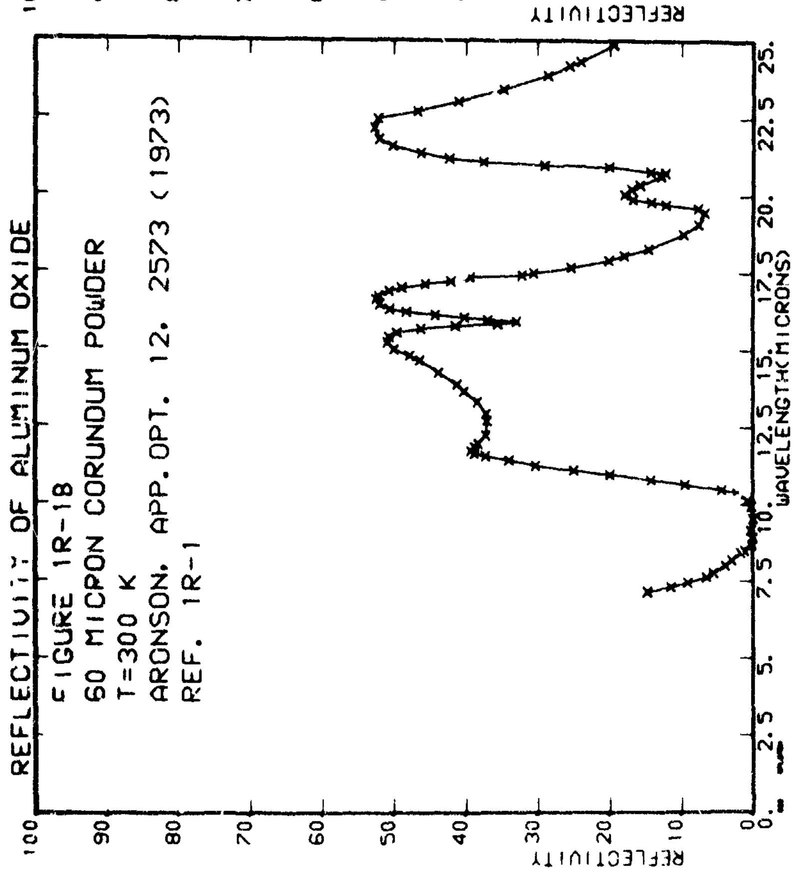
Aronson (Ref. 1R-1)

b. Particle size = 50μ diameter. LWA powder from Microabrasives Corp.

λ	R	λ	R	λ	R
7.150	1.469E+01	7.314	1.145E+01	7.453	9.112E+00
7.542	6.548E+00	7.772	5.496E+00	8.014	3.864E+00
8.175	2.934E+00	8.428	1.715E+00	8.521	1.198E+00
8.595	1.033E-01	8.900	6.198E-02	9.164	3.719E-01
9.530	4.132E-02	9.929	2.686E-01	10.138	7.025E-01
10.353	2.252E+00	10.463	4.483E+00	10.546	9.587E+00
10.785	1.426E+01	10.948	1.992E+01	11.094	2.501E+01
11.237	3.029E+01	11.403	3.401E+01	11.523	3.725E+01
11.533	3.880E+01	11.761	3.939E+01	11.827	3.884E+01
11.939	3.835E+01	12.214	3.727E+01	12.673	3.705E+01
12.920	3.715E+01	13.273	3.843E+01	13.540	4.830E+01
13.351	4.124E+01	14.239	4.359E+01	14.535	4.655E+01
14.785	4.790E+01	14.976	5.008E+01	15.222	5.096E+01
15.388	5.074E+01	15.543	4.962E+01	15.372	4.633E+01
15.750	4.145E+01	15.629	3.556E+01	15.902	3.308E+01
15.953	3.695E+01	16.037	4.628E+01	16.114	4.423E+01
16.200	4.832E+01	16.292	5.054E+01	16.472	5.202E+01
16.542	5.257E+01	16.743	5.214E+01	16.897	5.068E+01
16.973	4.894E+01	17.109	4.561E+01	17.222	4.238E+01
17.337	3.947E+01	17.422	3.228E+01	17.486	3.051E+01
17.651	2.545E+01	17.922	2.016E+01	18.056	1.808E+01
18.259	1.467E+01	18.749	9.773E+00	19.092	7.685E+00
19.455	5.816E+00	19.601	7.707E+00	19.714	1.221E+01
19.808	1.421E+01	19.880	1.588E+01	20.024	1.800E+01
20.199	1.739E+01	20.356	1.585E+01	20.538	1.285E+01
20.745	1.223E+01	20.789	1.436E+01	20.929	2.014E+01
20.995	2.908E+01	21.075	3.754E+01	21.178	4.232E+01
21.354	4.639E+01	21.582	5.022E+01	21.804	5.200E+01
22.138	5.275E+01	22.478	5.226E+01	22.714	4.681E+01
23.040	4.118E+01	23.435	3.481E+01	23.896	2.864E+01
24.181	2.576E+01	24.340	2.413E+01	24.894	1.957E+01
25.372	1.632E+01	25.736	1.506E+01	26.263	1.665E+01
26.531	1.473E+01	26.782	1.314E+01	27.968	1.209E+01
27.521	1.143E+01	28.448	1.093E+01		



REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1B
60 MICRON CORUNDUM POWDER
T=300 K
ARONSON, APP.OPT. 12, 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)

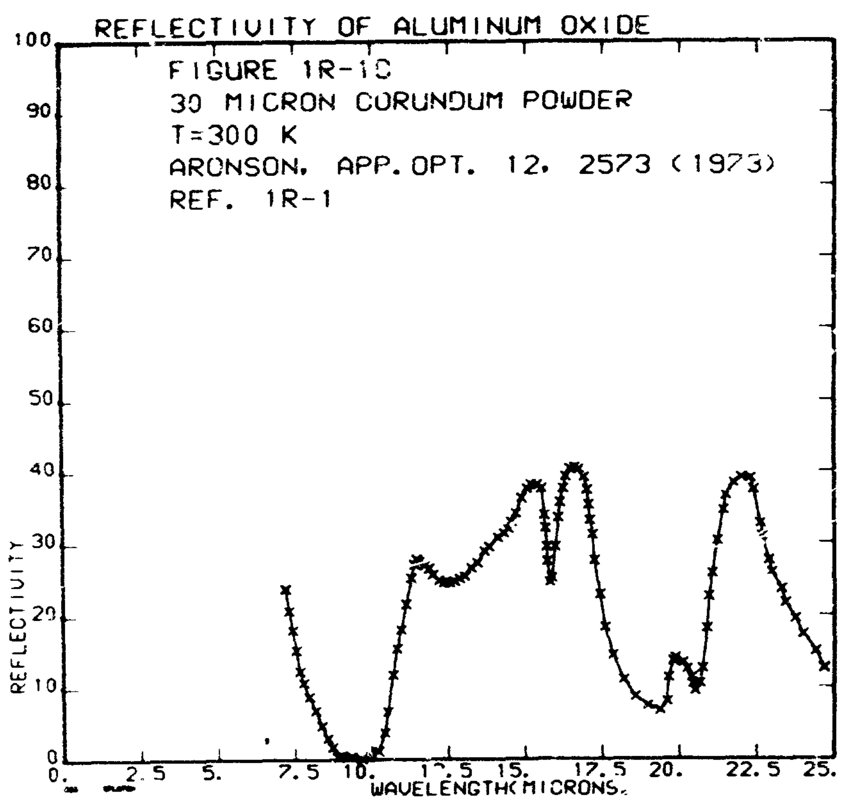


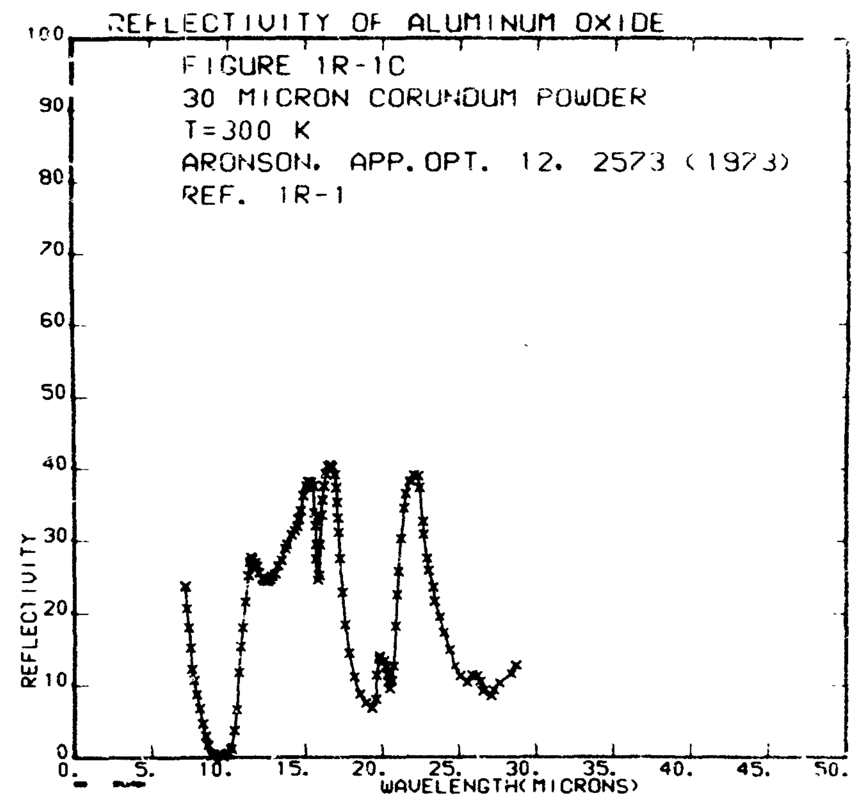
REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1B
60 MICPON CORUNDUM POWDER
T=300 K
ARONSON, APP.OPT. 12, 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)

Aronson (Ref. 1R-1)

c. Particle size = 30 μm diameter. LWA powder from Microabrasives Corp.

λ	R	λ	R	λ	R
7.221	2.377E+01	7.332	2.071E+01	7.448	1.802E+01
7.563	1.521E+01	7.679	1.231E+01	7.817	1.074E+01
7.933	8.741E+00	8.187	6.798E+00	8.392	4.690E+00
8.579	3.017E+00	8.731	1.694E+00	8.916	3.512E-01
9.034	4.959E-01	9.349	4.132E-01	9.584	1.033E-01
9.997	5.165E-01	10.243	1.136E+00	10.423	3.719E+00
10.545	6.632E+00	10.713	1.182E+01	10.829	1.539E+01
10.978	1.804E+01	11.133	2.165E+01	11.310	2.527E+01
11.421	2.711E+01	11.485	2.780E+01	11.570	2.754E+01
11.751	2.703E+01	11.892	2.632E+01	11.999	2.564E+01
12.222	2.469E+01	12.370	2.452E+01	12.547	2.454E+01
12.702	2.470E+01	12.893	2.511E+01	13.069	2.546E+01
13.261	2.662E+01	13.458	2.733E+01	13.696	2.892E+01
13.835	2.957E+01	14.136	3.084E+01	14.300	3.143E+01
14.455	3.202E+01	14.371	3.299E+01	14.703	3.428E+01
14.891	3.635E+01	15.066	3.754E+01	15.192	3.821E+01
15.375	3.815E+01	15.527	3.762E+01	15.528	3.391E+01
15.656	3.218E+01	15.702	2.953E+01	15.724	2.749E+01
15.811	2.464E+01	15.896	2.519E+01	15.973	2.953E+01
16.091	3.365E+01	16.130	3.570E+01	16.229	3.764E+01
16.311	3.931E+01	16.469	4.044E+01	16.517	4.066E+01
16.734	4.03[illegible]E+01	16.911	3.921E+01	16.998	3.741E+01
17.056	3.546E+01	17.115	3.324E+01	17.177	3.128E+01
17.261	2.705E+01	17.443	2.297E+01	17.620	1.841E+01
17.851	1.459E+01	18.198	1.110E+01	18.591	8.719E+00
18.978	7.583E+00	19.394	6.860E+00	19.501	8.817E+00
19.571	1.149E+01	19.800	1.370E+01	19.892	1.411E+01
20.14[illegible]	1.349E+01	20.256	1.250E+01	20.406	1.143E+01
20.454	1.050E+01	20.540	9.544E+00	20.581	1.364E+01
20.75[illegible]	1.271E+01	20.911	1.320E+01	20.951	2.261E+01
21.079	2.589E+01	21.228	3.035E+01	21.433	3.460E+01
21.498	3.668E+01	21.766	3.837E+01	22.001	3.919E+01
22.307	3.906E+01	22.407	3.743E+01	22.526	3.275E+01
22.538	3.090E+01	22.902	2.766E+01	23.008	2.599E+01
23.298	2.307E+01	23.430	2.169E+01	23.765	1.957E+01
24.005	1.735E+01	24.412	1.508E+01	24.596	1.273E+01
25.140	1.134E+01	25.583	1.037E+01	25.891	1.145E+01
26.2[illegible]7	1.138E+01	26.403	1.050E+01	26.573	9.112E+00
27.096	8.574E+00	27.248	9.380E+00	27.675	1.031E+01
28.339	1.159E+01	28.721	1.287E+01		

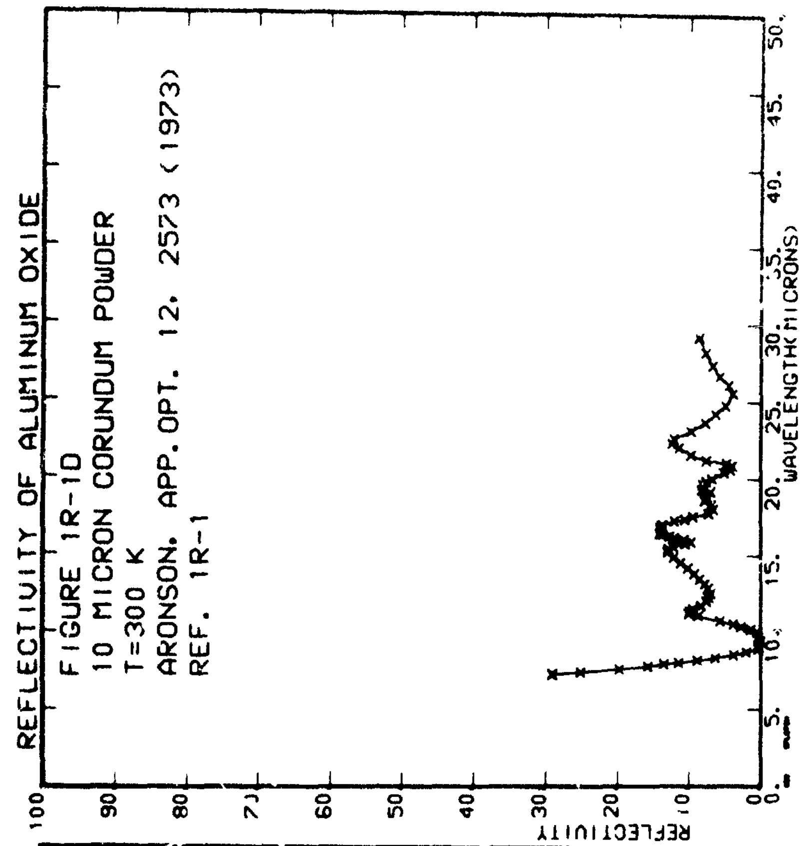

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1C
30 MICRON CORUNDUM POWDER
T=300 K
ARONSON, APP.OPT. 12, 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

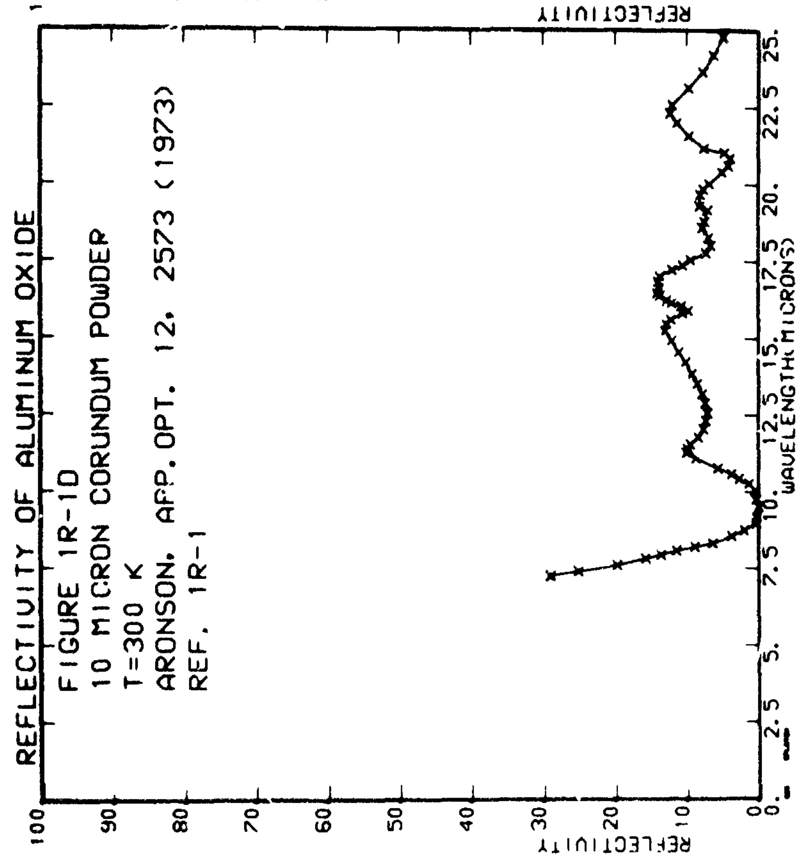

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1C
30 MICRON CORUNDUM POWDER
T=300 K
ARONSON, APP.OPT. 12, 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

Aronson (Ref. 1R-1)

d. *Particle size* = 10μ diameter. LWA powder from Microabrasives Corp.

λ	R	λ	R	λ	R
7.250	2.905E+01	7.414	2.515E+01	7.505	1.971E+01
7.835	1.575E+01	7.961	1.355E+01	8.090	1.147E+01
8.233	8.602E+00	8.347	6.488E+00	8.550	3.802E+00
8.738	2.004E+00	8.985	3.306E-01	9.174	3.306E-01
9.539	2.005E-02	9.752	3.306E-01	10.066	4.752E-01
10.284	1.322E+00	10.435	2.707E+00	10.591	3.884E+00
10.730	5.744E+00	11.117	8.700E+00	11.284	1.002E+01
11.416	9.743E+00	11.550	9.442E+00	11.792	8.326E+00
12.051	7.624E+00	12.327	7.335E+00	12.593	7.107E+00
12.917	7.417E+00	13.218	7.831E+00	13.540	8.574E+00
13.856	9.235E+00	14.227	1.014E+01	14.566	1.118E+01
14.935	1.215E+01	15.266	1.300E+01	15.479	1.289E+01
15.521	1.223E+01	15.826	1.054E+01	15.919	9.773E+00
16.055	1.075E+01	16.169	1.217E+01	15.247	1.281E+01
16.399	1.370E+01	16.483	1.417E+01	16.672	1.399E+01
16.852	1.395E+01	17.045	1.376E+01	17.246	1.207E+01
17.375	1.052E+01	17.558	9.431E+00	17.791	7.335E+00
18.033	5.715E+00	18.296	7.025E+00	18.515	7.831E+00
18.809	7.562E+00	19.188	7.107E+00	19.303	8.202E+00
19.579	8.099E+00	19.848	7.748E+00	20.024	6.983E+00
20.422	5.227E+00	20.617	4.339E+00	20.872	4.050E+00
21.025	4.876E+00	21.196	7.665E+00	21.591	9.731E+00
22.021	1.147E+01	22.302	1.246E+01	22.595	1.215E+01
23.136	9.711E+00	23.652	7.810E+00	24.204	6.467E+00
24.788	5.083E+00	25.556	3.986E+00	26.117	4.565E+00
26.666	5.806E+00	27.376	6.816E+00	28.204	7.748E+00
29.205	6.678E+00				

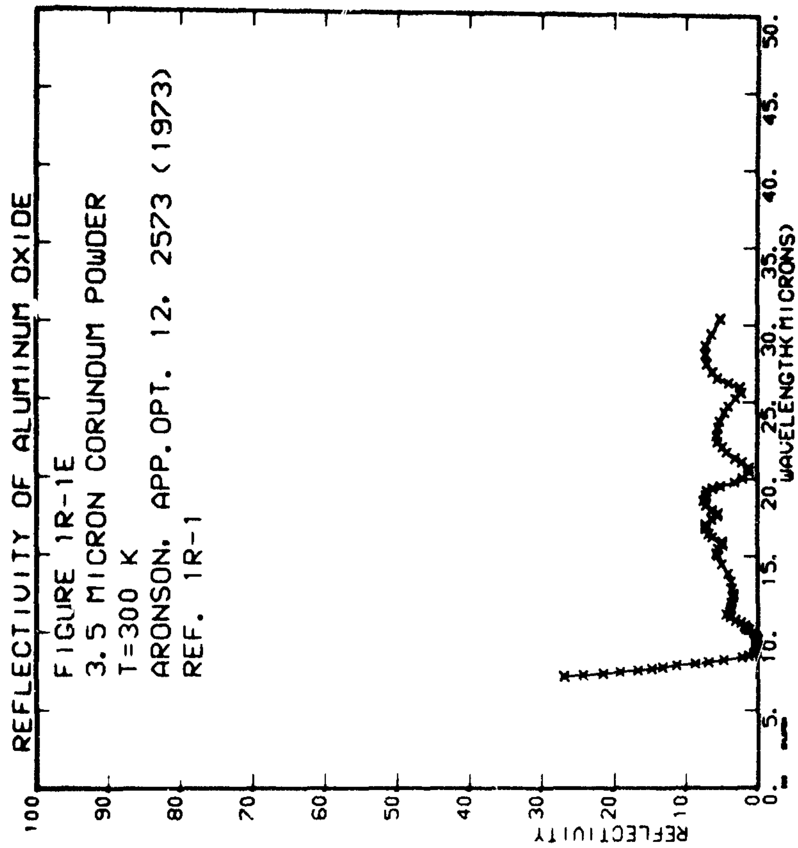

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1D
10 MICRON CORUNDUM POWDER
T=300 K
ARONSON. APP.OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 10 20 30 40 50 60 70 80 90 100
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.

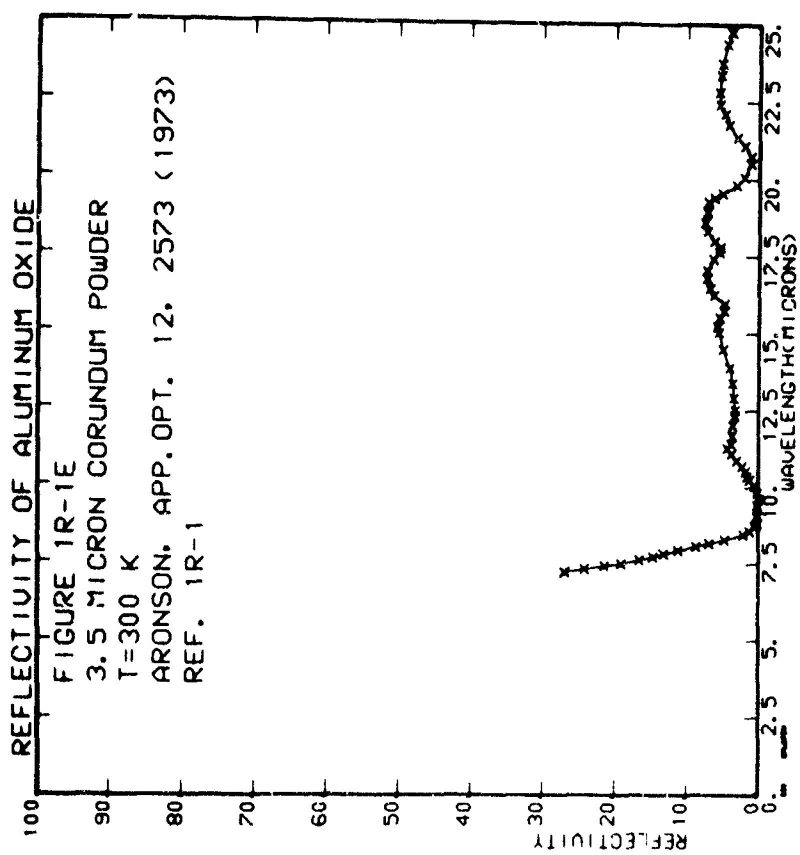

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1D
10 MICRON CORUNDUM POWDER
T=300 K
ARONSON. APP.OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Aronson (Ref. 1R-1)

e. Particle size = 3.5μ diameter. LWA powder from Microabrasives Corp.

λ	R	λ	R	λ	R
7.226	2.692E+01	7.325	2.422E+01	7.443	2.143E+01
7.519	1.909E+01	7.624	1.657E+01	7.728	1.475E+01
7.838	1.329E+01	7.965	1.122E+01	8.094	8.636E+00
8.188	6.886E+00	8.317	4.752E+00	8.477	2.169E+00
8.585	1.198E+00	8.723	4.959E-01	8.842	1.653E-01
9.064	2.686E-01	9.434	2.686E-01	9.537	4.132E-02
9.929	2.893E-01	10.067	5.165E-01	10.266	1.260E+00
10.368	1.612E+00	10.528	1.850E+00	10.712	2.293E+00
10.835	3.144E+00	11.114	3.884E+00	11.283	4.421E+00
11.430	3.967E+00	11.693	3.740E+00	12.025	3.616E+00
12.350	3.306E+00	12.546	3.306E+00	12.930	3.533E+00
13.413	3.698E+00	13.915	4.132E+00	14.509	5.021E+00
15.064	5.640E+00	15.231	5.826E+00	15.534	5.517E+00
15.755	4.897E+00	15.973	4.938E+00	16.255	6.384E+00
16.475	6.818E+00	16.888	7.273E+00	17.059	7.190E+00
17.440	6.488E+00	17.651	5.682E+00	17.610	5.517E+00
18.013	6.302E+00	18.323	7.211E+00	18.598	7.521E+00
18.957	7.252E+00	19.292	7.128E+00	19.409	6.343E+00
19.551	5.289E+00	19.828	3.202E+00	20.093	2.107E+00
20.540	1.240E+00	20.759	1.219E+00	21.106	2.107E+00
21.383	3.140E+00	21.794	4.339E+00	22.138	4.979E+00
22.437	5.640E+00	22.839	5.764E+00	23.386	5.517E+00
23.765	5.310E+00	24.388	4.669E+00	24.788	4.050E+00
25.249	3.017E+00	25.622	2.231E+00	25.959	2.459E+00
26.270	4.008E+00	26.959	5.620E+00	26.965	6.302E+00
27.475	7.169E+00	28.100	7.273E+00	28.663	7.231E+00
29.414	6.488E+00	30.437	5.289E+00		

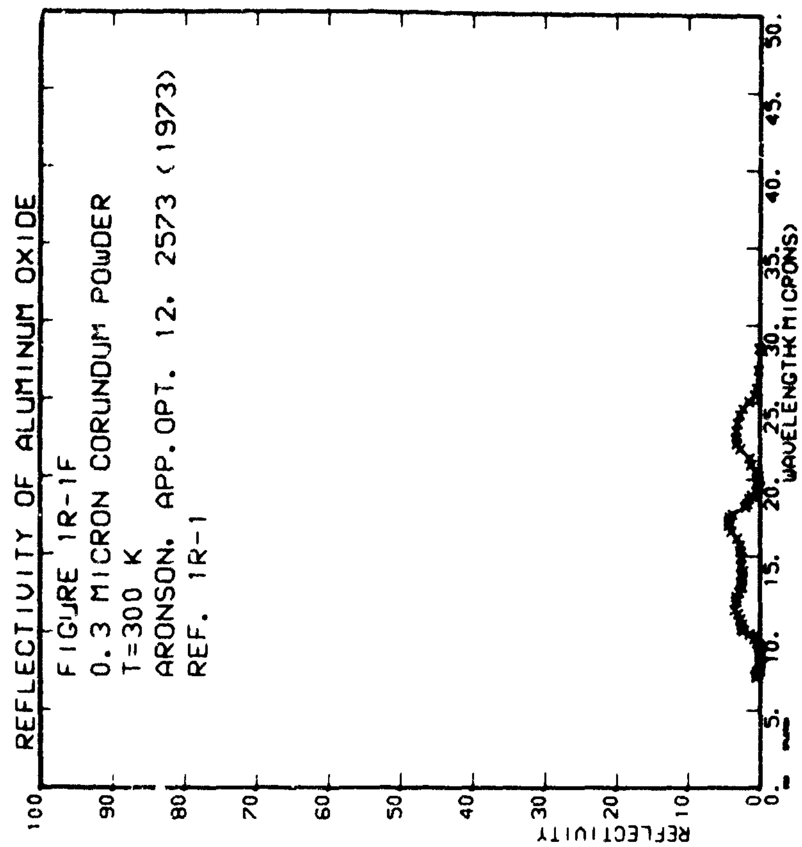

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1E
3.5 MICRON CORUNDUM POWDER
T=300 K
ARONSON, APP.OPT. 12, 2573 (1973)
REF. 1R-1
REFLECTIVITY
0 10 20 30 40 50 60 70 80 90 100
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.

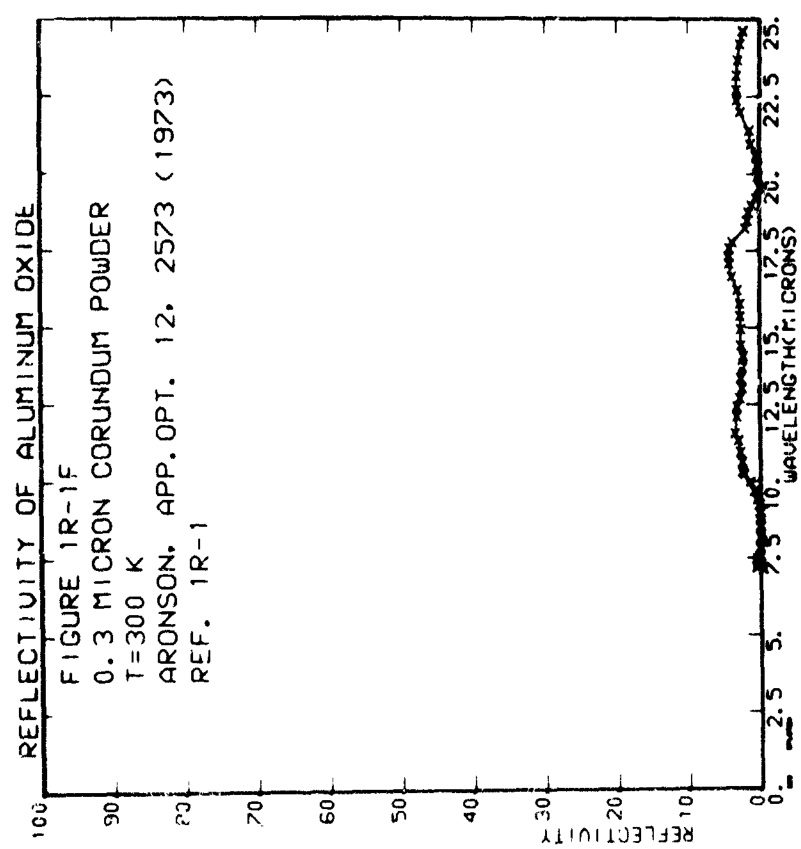

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1E
3.5 MICRON CORUNDUM POWDER
T=300 K
ARONSON, APP.OPT. 12, 2573 (1973)
REF. 1R-1
REFLECTIVITY
0 10 20 30 40 50 60 70 80 90 100
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Aronson (Ref. 1R-1)

f   Particle size = 0.3μ diameter. Supplied by Adolf Meller Co.

λ	R	λ	R	λ	R
7.207	5.372E-01	7.356	4.545E-01	7.496	4.545E-01
7.570	4.132E-02	7.824	6.198E-02	8.194	6.198E-02
8.557	8.264E-02	8.759	8.254E-02	8.996	8.264E-02
9.232	1.653E-01	9.419	3.926E-01	9.676	8.678E-01
9.973	1.446E+00	10.225	2.231E+00	10.320	2.583E+00
10.538	2.521E+00	10.971	2.748E+00	11.326	3.058E+00
11.599	3.533E+00	12.118	3.223E+00	12.433	3.202E+00
12.719	2.672E+00	13.026	2.438E+00	13.355	2.624E+00
13.702	2.397E+00	14.074	2.314E+00	14.436	2.524E+00
14.972	2.624E+00	15.376	2.769E+00	15.794	2.707E+00
16.234	3.140E+00	16.664	3.926E+00	17.086	4.360E+00
17.321	4.360E+00	17.592	4.215E+00	17.794	3.843E+00
18.245	2.087E+00	18.494	1.694E+00	18.770	1.550E+00
18.993	1.157E+00	19.229	5.579E-01	19.570	8.264E-02
19.968	3.512E-01	20.248	3.512E-01	20.583	5.785E-01
20.955	1.193E+00	21.415	1.446E+00	22.001	2.789E+00
22.352	3.223E+00	22.745	3.285E+00	23.174	3.244E+00
23.575	3.037E+00	24.222	2.727E+00	24.629	2.293E+00
25.051	1.529E+00	25.523	7.438E-01	25.932	3.926E-01
27.038	2.273E-01	28.530	1.653E-01		


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1F
0.3 MICRON CORUNDUM POWDER
T=300 K
ARONSON. APP.OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

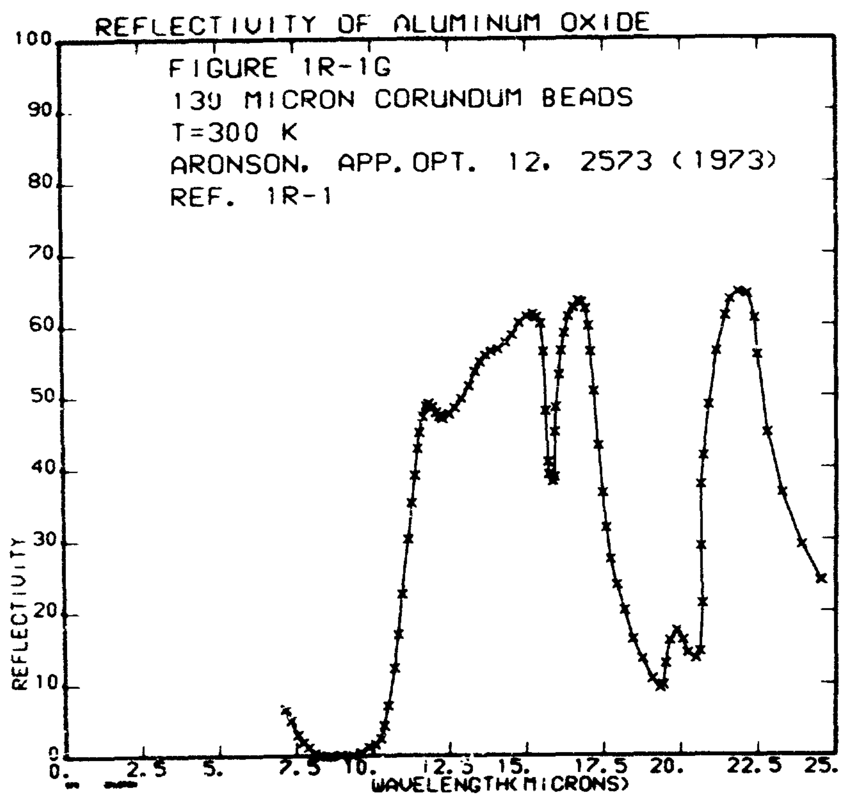

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1F
0.3 MICRON CORUNDUM POWDER
T=300 K
ARONSON. APP.OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

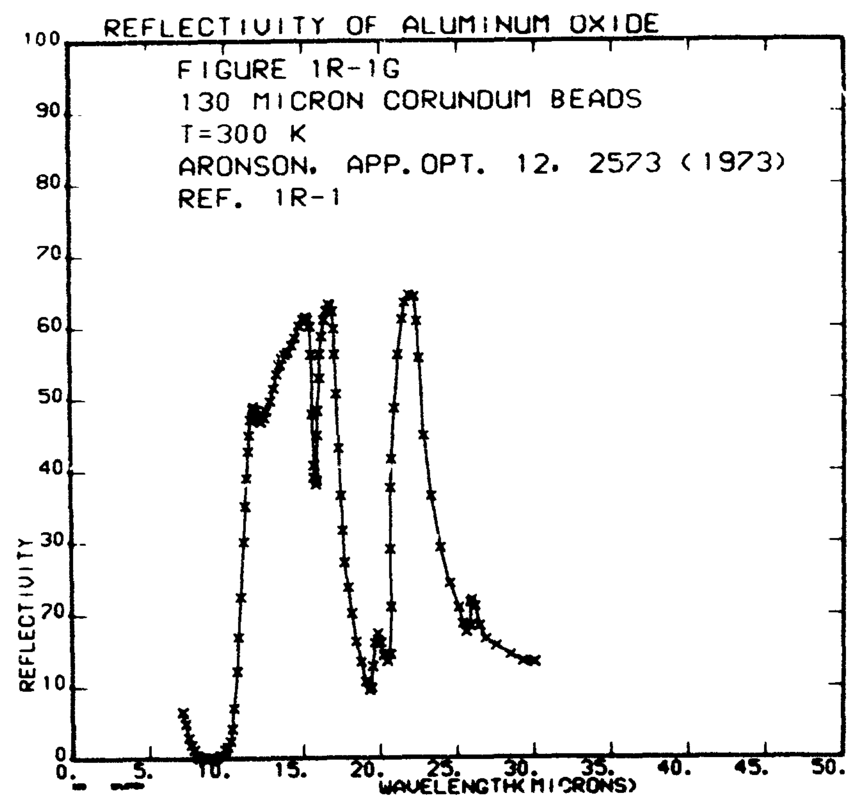
Aronson (Ref. 1R-1)

ii) The reflectivity of corundum beads of 35μ and 130μ diameter has been measured using a Michaelson interferometer. The beads have been melted to a spherical shape and annealed until the composition was entirely α - Al_2O_3. No spectral bandpass or error analysis is given. The temperature is approximately 300°K. Data were digitized from lines.

g. Bead diameter = 130μ.

λ	R	λ	R	λ	R
7.137	6.446E+00	7.364	4.839E+00	[illegible].568	2.892E+00
7.727	1.988E+00	7.913	1.265E+00	8.899	3.213E-01
9.353	2.008E-02	9.615	4.418E-01	9.896	1.225E+00
10.379	1.627E+00	10.270	2.470E+00	10.387	4.116E+00
10.518	6.908E+00	10.699	1.211E+01	10.835	1.695E+01
10.955	2.240E+01	11.154	3.011E+01	11.281	3.515E+01
11.356	3.907E+01	11.471	4.270E+01	11.535	4.505E+01
11.544	4.720E+01	11.760	4.859E+01	11.845	4.902E+01
11.956	4.655E+01	12.083	4.771E+01	12.184	4.726E+01
12.295	4.693E+01	12.511	4.751E+01	12.681	4.847E+01
12.595	4.975E+01	13.139	5.153E+01	13.340	5.350E+01
13.513	5.467E+01	13.691	5.573E+01	13.863	5.620E+01
14.085	5.650E+01	14.327	5.751E+01	14.529	5.859E+01
14.705	5.031E+01	15.021	6.124E+01	15.216	6.157E+01
15.343	6.112E+01	15.466	6.026E+01	15.552	5.622E+01
15.635	4.796E+01	15.705	4.080E+01	15.741	3.917E+01
15.853	3.611E+01	15.915	3.871E+01	15.941	4.501E+01
15.959	4.847E+01	16.053	5.299E+01	16.143	5.630E+01
16.242	5.885E+01	16.364	6.110E+01	16.504	6.244E+01
16.575	6.332E+01	16.787	6.312E+01	16.921	6.226E+01
17.019	5.985E+01	17.090	5.626E+01	17.174	5.076E+01
17.325	4.317E+01	17.476	3.656E+01	17.581	3.172E+01
17.740	2.721E+01	17.942	2.373E+01	18.182	2.012E+01
18.448	1.627E+01	18.749	1.335E+01	19.089	1.060E+01
19.323	9.395E+00	19.444	9.799E+00	19.519	1.269E+01
19.539	1.608E+01	19.895	1.747E+01	20.080	1.614E+01
20.235	1.425E+01	20.491	1.345E+01	20.547	1.446E+01
20.741	2.143E+01	20.660	2.906E+01	20.864	3.768E+01
20.741	4.105E+02	20.919	4.871E+01	21.153	5.628E+01
21.438	6.124E+01	21.581	6.352E+01	21.654	6.450E+01
22.163	6.430E+01	22.386	6.092E+01	22.497	5.569E+01
22.334	4.439E+01	23.297	3.641E+01	23.314	2.924E+01
24.555	2.435E+01	25.116	2.097E+01	25.345	1.876E+01
25.530	1.767E+01	25.855	1.845E+01	25.849	2.159E+01
25.955	2.209E+01	26.164	2.113E+01	25.454	1.955E+01
26.852	1.661E+01	27.590	1.560E+01	28.461	1.436E+01
29.288	1.343E+01	30.023	1.331E+01		

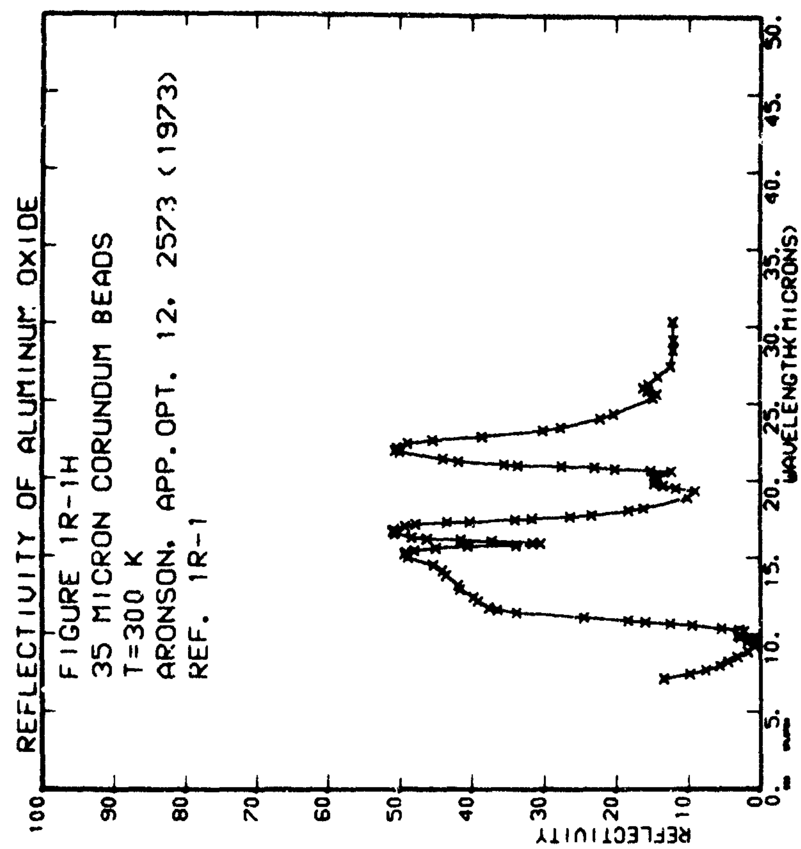

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1G
130 MICRON CORUNDUM BEADS
T=300 K
ARONSON. APP. OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH (MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
0
10
20
30
40
50
60
70
80
90
100


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1G
130 MICRON CORUNDUM BEADS
T=300 K
ARONSON. APP. OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH (MICRONS)
0.
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.
0
10
20
30
40
50
60
70
80
90
100

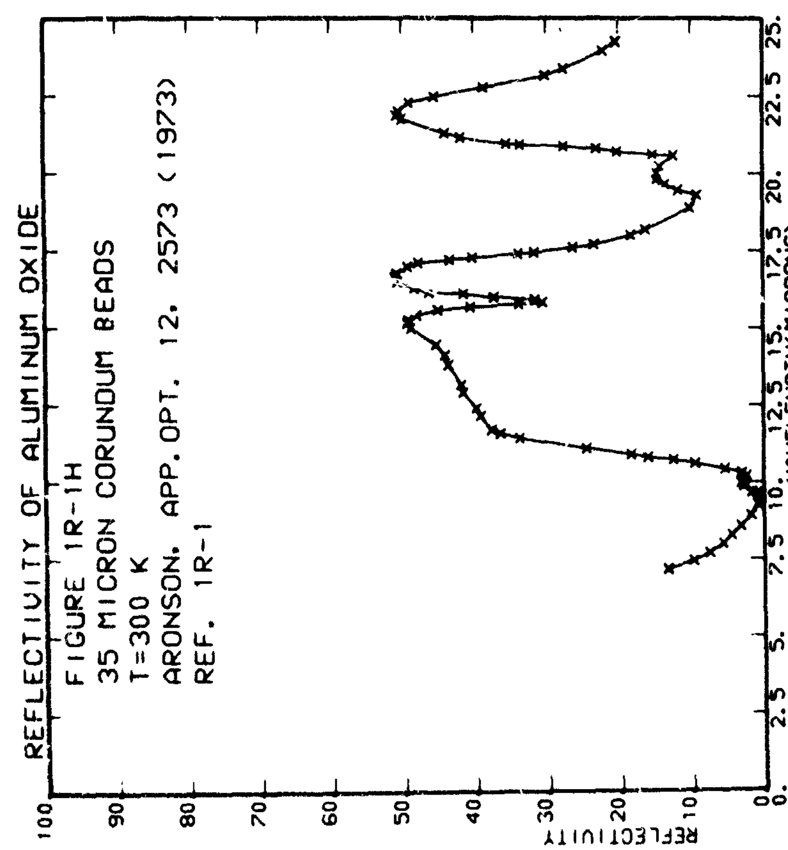
Aronson (Ref. 1R-1)

h. Bead diameter = 35μ.

λ	R	λ	R	λ	R
7.194	1.343E+01	7.468	9.839E+00	7.698	7.651E+00
8.000	5.643E+00	8.286	4.479E+00	8.575	3.092E+00
8.438	1.747E+00	9.296	8.635E-01	9.549	4.217E-01
9.053	1.044E+00	9.576	1.627E+00	9.883	2.771E+00
9.431	3.032E+00	10.096	2.691E+00	10.212	2.309E+00
10.305	2.912E+00	10.444	5.352E+00	10.510	9.578E+00
10.723	1.257E+01	10.804	1.606E+01	10.909	1.837E+01
11.204	2.459E+01	11.441	3.380E+01	11.581	3.654E+01
11.739	3.776E+01	12.159	3.911E+01	12.409	3.378E+01
12.315	4.162E+01	13.150	4.196E+01	13.801	4.360E+01
14.125	4.439E+01	14.471	4.532E+01	14.977	4.886E+01
15.151	4.932E+01	15.257	4.916E+01	15.417	4.795E+01
15.575	4.5[illegible]1E+01	15.696	4.055E+01	15.774	3.388E+01
15.845	3.055E+01	15.933	3.150E+01	16.014	3.734E+01
16.100	4.151E+01	16.172	4.624E+01	16.293	4.838E+01
16.501	5.072E+01	16.650	5.106E+01	16.784	5.084E+01
16.932	4.924E+01	17.132	4.759E+01	17.200	4.348E+01
17.278	4.027E+01	17.419	3.396E+01	17.464	3.168E+01
17.5[illegible]9	2.638E+01	17.722	2.348E+01	18.022	1.825E+01
18.179	1.627E+01	18.804	1.016E+01	19.316	9.095E+00
19.459	1.179E+01	19.669	1.349E+01	19.783	1.484E+01
20.000	1.476E+01	20.230	1.434E+01	20.575	1.231E+01
20.513	1.520E+01	20.767	2.018E+01	20.601	2.306E+01
20.934	2.739E+01	20.923	3.355E+01	20.962	3.549E+01
21.471	4.182E+01	21.306	4.407E+01	21.759	5.002E+01
21.892	5.074E+01	22.012	5.049E+01	22.296	4.892E+01
22.437	4.540E+01	22.793	3.869E+01	23.168	3.019E+01
23.373	2.709E+01	23.971	2.226E+01	24.256	2.034E+01
25.333	1.436E+01	25.591	1.432E+01	25.784	1.568E+01
25.940	1.624E+01	26.164	1.556E+01	26.715	1.424E+01
27.377	1.243E+01	28.398	1.219E+01	29.864	1.203E+01
30.262	1.211E+01				



REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1H
35 MICRON CORUNDUM BEADS
T=300 K
ARONSON, APP.OPT. 12, 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)



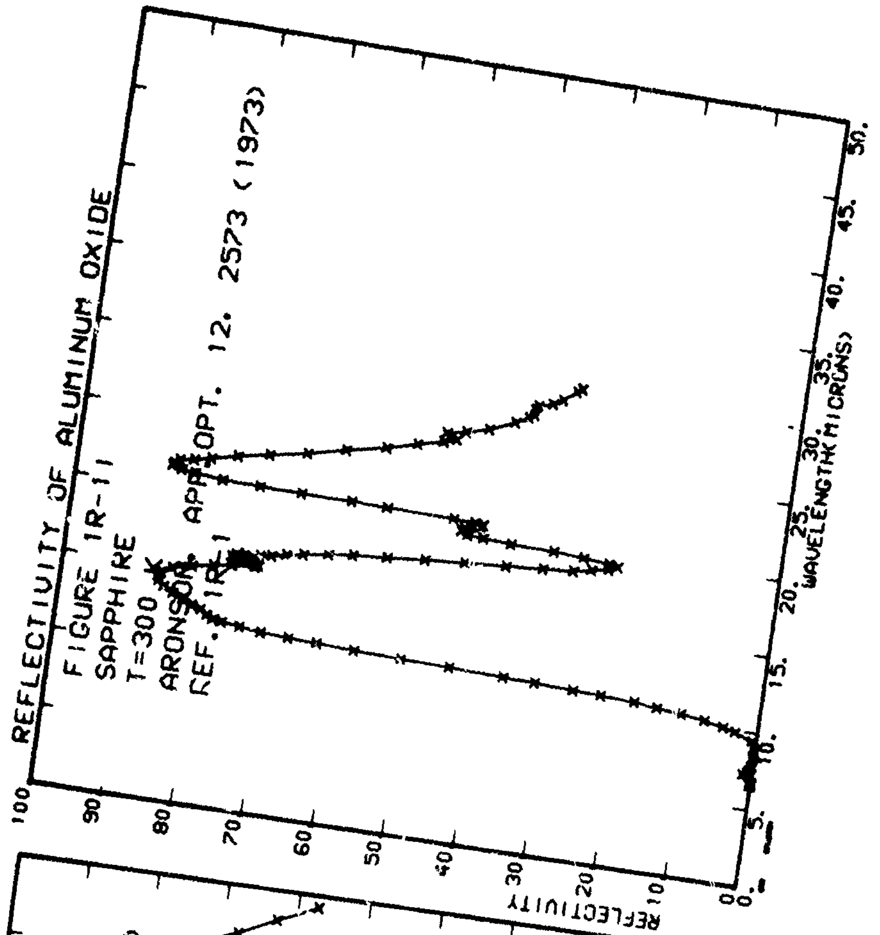
REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1H
35 MICRON CORUNDUM BEADS
T=300 K
ARONSON, APP.OPT. 12, 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)

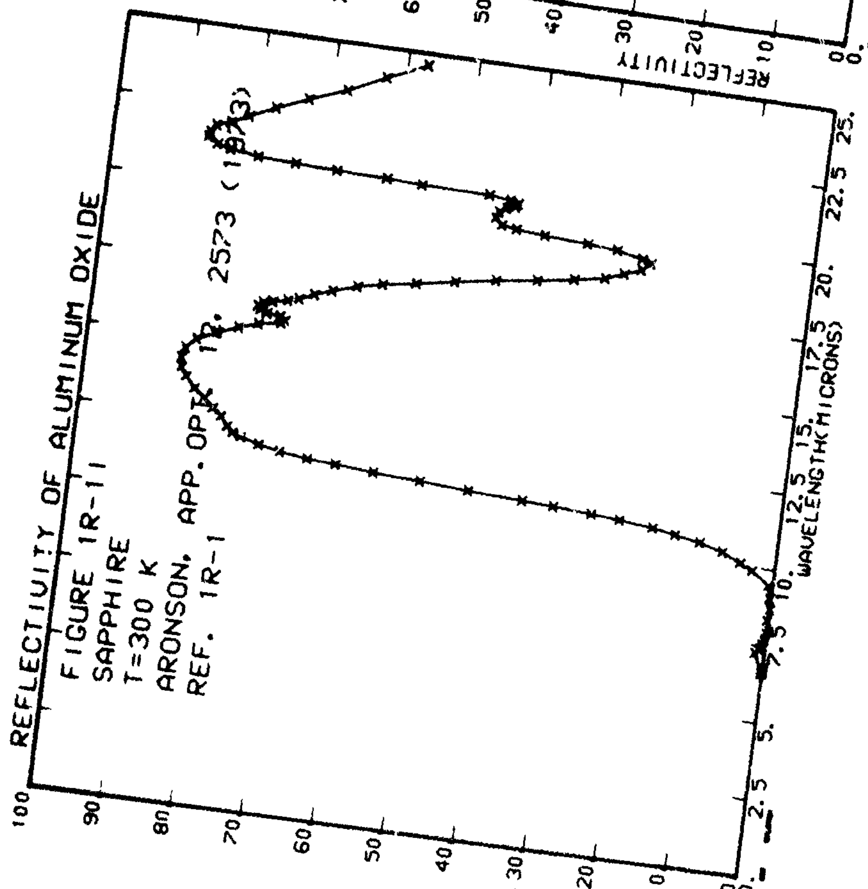
Aronson (Ref. 1R-1)

iii) The changes in reflectivity of randomly oriented sapphire occuring from abrasion by 15μ diamond polishing compound shows the change in magnitude but not shape of the reflectance caused by surface asperities. No spectral bandpass or error analysis is given. The temperature is approximately 300°K. Data were digitized from lines.

i. Sapphire crystal, unabraded surface.

λ	R	λ	R	λ	R
7.200	1.381E+00	7.419	7.808E-01	7.556	5.405E-01
7.759	2.803E-01	7.943	1.832E-01	8.363	2.803E-01
8.746	8.006E-02	9.075	2.402E-01	9.481	6.006E-01
9.907	3.143E+00	10.111	4.855E+00	10.382	7.508E+00
10.394	1.097E+01	10.738	1.447E+01	10.850	1.778E+01
10.95[illegible]	2.244E+01	11.033	2.646E+01	11.103	3.199E+01
11.153	3.638E+01	11.246	4.403E+01	11.330	5.095E+01
11.413	5.792E+01	11.506	6.294E+01	11.563	6.703E+01
11.575	7.094E+01	11.818	7.399E+01	11.985	7.661E+01
12.077	7.785E+01	12.271	7.872E+01	12.549	7.975E+01
12.759	8.133E+01	13.059	8.240E+01	13.339	8.398E+01
13.574	8.530E+01	13.903	8.618E+01	14.269	8.534E+01
14.587	8.591E+01	14.913	8.454E+01	15.215	8.177E+01
15.404	7.834E+01	15.655	7.822E+01	15.779	7.308E+01
15.893	7.251E+01	15.991	7.336E+01	16.039	7.527E+01
16.142	7.615E+01	16.242	7.649E+01	16.348	7.592E+01
16.447	7.400E+01	16.534	7.257E+01	16.544	7.092E+01
16.825	6.897E+01	17.044	6.652E+01	17.235	6.303E+01
17.469	5.968E+01	17.535	5.492E+01	17.848	4.954E+01
18.083	4.337E+01	18.258	3.821E+01	18.460	3.303E+01
18.531	2.874E+01	18.857	2.624E+01	19.068	2.388E+01
19.393	2.265E+01	19.422	2.336E+01	19.574	2.754E+01
19.570	3.179E+01	19.746	3.789E+01	19.810	4.194E+01
19.869	4.415E+01	20.084	4.518E+01	20.274	4.476E+01
20.4[illegible]3	4.373E+01	20.544	4.246E+01	20.545	4.212E+01
20.[illegible]	4.333E+01	20.773	4.641E+01	20.807	5.587E+01
20.[illegible]1	6.093E+01	20.890	6.600E+01	20.942	7.393E+01
20.994	7.927E+01	21.105	8.326E+01	21.220	8.513E+01
21.419	8.655E+01	21.562	8.634E+01	21.819	8.561E+01
21.807	8.361E+01	22.239	8.123E+01	22.615	7.767E+01
23.035	7.329E+01	23.481	6.864E+01	24.049	6.272E+01
24.026	5.715E+01	25.159	5.294E+01	25.586	4.938E+01
25.324	4.762E+01	26.153	4.917E+01	26.430	4.639E+01
26.331	4.325E+01	27.521	3.986E+01	27.972	3.807E+01
28.137	3.725E+01	28.579	3.730E+01	28.796	3.693E+01
29.073	3.492E+01	29.446	3.360E+01	30.053	3.179E+01
30.337	3.112E+01				

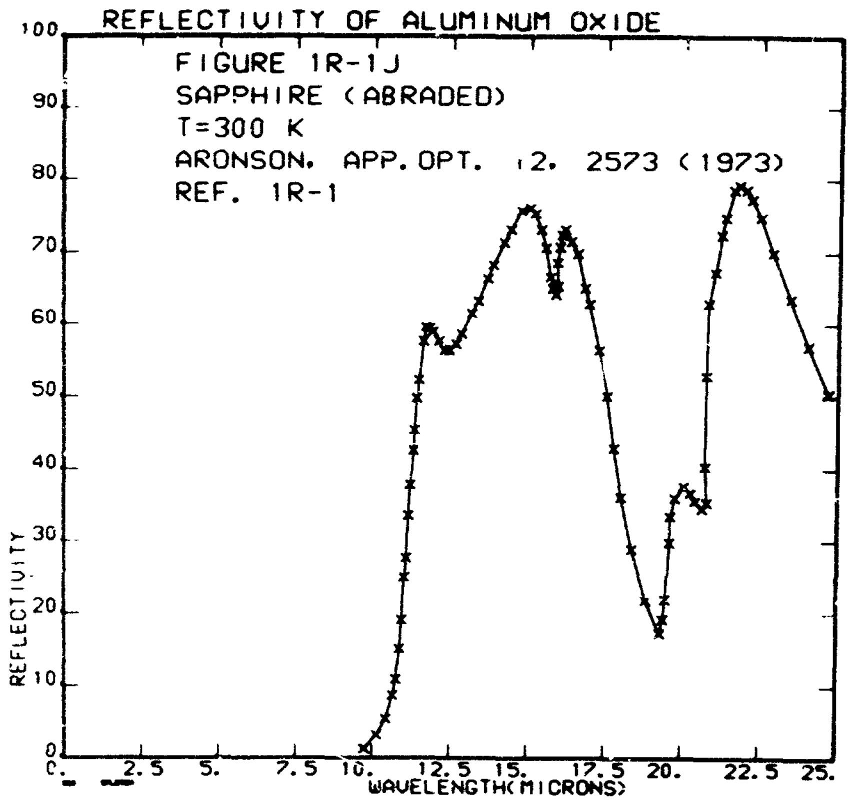

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-11
SAPPHIRE
T=300
ARONSON, APP. OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
0. 10 20 30 40 50 60 70 80 90 100
WAVELENGTH(MICRONS)
5. 10. 15. 20. 25. 30. 35. 40. 45. 50.

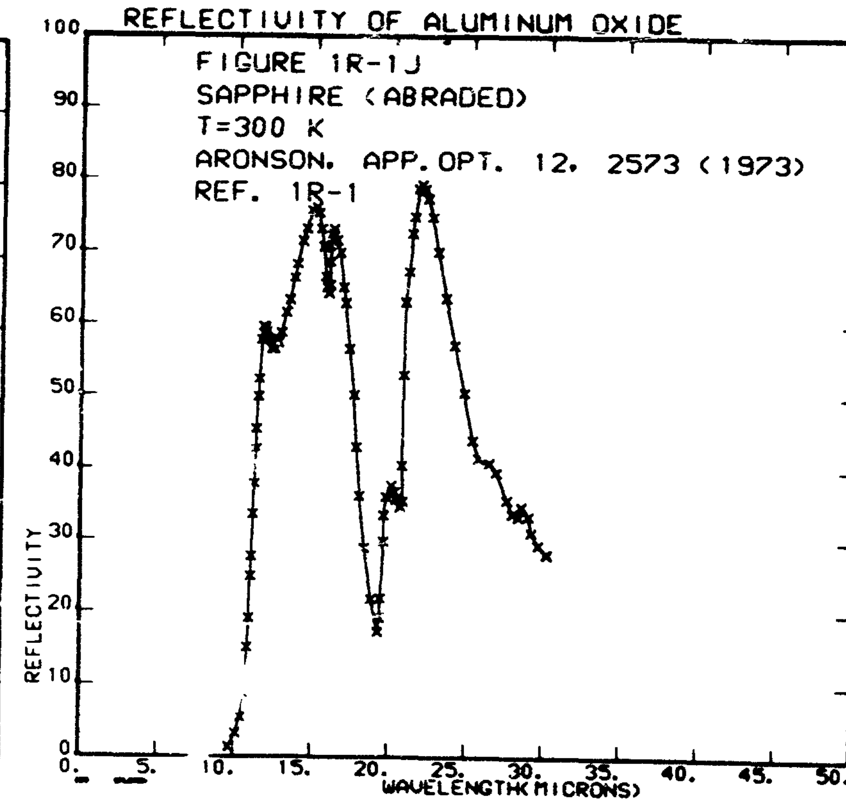

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-11
SAPPHIRE
T=300 K
ARONSON, APP. OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
0. 10 20 30 40 50 60 70 80 90 100
WAVELENGTH(MICRONS)
2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Ar[illegible]son (Ref. 1R-1)

1. Sapphire crystal, surface abraded with 15μ diamond paste.

λ	R	λ	R	λ	R
9.703	1.341E+00	10.161	3.223E+00	10.468	5.425E+00
10.535	8.729E+00	10.782	1.089E+01	10.884	1.512E+01
10.959	1.912E+01	11.036	2.504E+01	11.079	2.776E+01
11.153	3.368E+01	11.217	3.781E+01	11.302	4.268E+01
11.339	4.540E+01	11.422	4.986E+01	11.472	5.234E+01
11.534	5.778E+01	11.697	5.958E+01	11.818	5.950E+01
11.922	5.699E+01	12.117	5.774E+01	12.285	5.655E+01
12.437	5.653E+01	12.657	5.736E+01	12.847	5.875E+01
13.161	6.104E+01	13.369	6.331E+01	13.553	6.534E+01
13.842	6.830E+01	14.181	7.147E+01	14.398	7.314E+01
14.741	7.53[illegible]E+01	15.005	7.628E+01	15.189	7.541E+01
15.331	7.310E+01	15.540	7.078E+01	15.588	6.650E+01
15.756	6.502E+01	15.849	6.426E+01	15.944	6.530E+01
15.903	6.657E+01	15.997	7.088E+01	16.065	7.239E+01
16.158	7.314E+01	16.351	7.151E+01	16.565	6.989E+01
16.[illegible]9	6.502E+01	16.972	6.296E+01	17.279	5.657E+01
17.548	5.014E+01	17.775	4.292E+01	18.041	3.616E+01
18.332	2.698E+01	18.849	2.179E+01	19.318	1.734E+01
19.411	1.924E+01	19.487	2.193E+01	19.509	2.986E+01
19.632	3.354E+01	19.787	3.606E+01	20.352	3.764E+01
20.278	3.[illegible]73E+01	20.431	3.559E+01	20.549	3.461E+01
20.807	3.[illegible]7E+01	20.734	4.046E+01	20.756	5.298E+01
20.[illegible]7	6.[illegible]E+01	21.038	6.723E+01	21.207	7.245E+01
21.329	7.485E+01	21.594	7.872E+01	21.767	7.931E+01
21.977	7.672E+01	22.171	7.748E+01	22.458	7.488E+01
22.851	7.037E+01	23.427	6.351E+01	24.043	5.704E+01
24.031	5.[illegible]E+01	25.265	4.393E+01	25.663	4.145E+01
25.375	4.033E+01	26.324	3.953E+01	27.566	3.567E+01
27.925	3.376E+01	28.303	3.337E+01	28.532	3.476E+01
28.975	3.344E+01	29.189	3.114E+01	29.602	2.935E+01
30.159	2.809E+01				


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1J
SAPPHIRE (ABRADED)
T=300 K
ARONSON. APP.OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-1J
SAPPHIRE (ABRADED)
T=300 K
ARONSON. APP.OPT. 12. 2573 (1973)
REF. 1R-1
REFLECTIVITY
WAVELENGTH(MICRONS)

Aronson (IR-3)

A Perkin-Elmer Model 201-C spectrophotometer was used to measure the far-infrared reflection spectrum of alumina (Z-cut sapphire). Experimental details and bandpass information were not given. The data were digitized from a curve.

The representative curve for sapphire reflectance was in part constructed from this curve and is given in Section I - 1.6.

a T = 300°K; 0° orientation.

λ	R	λ	R	λ	R
		621.762	1.900E+01	346.821	1.967E+01
243.433	[illegible]	195.759	2.307E+01	179.910	2.447E+01
172.414	[illegible]	170.213	2.646E+01	158.103	2.848E+01
148.331	[illegible]	143.369	3.111E+01	132.450	3.083E+01
116.335	[illegible]	109.589	3.173E+01	105.263	3.352E+01
101.013	3.441E+01	95.525	3.262E+01	91.298	3.071E+01
[illegible]	2.974E+01	79.819	3.067E+01	77.764	2.927E+01
[illegible]	[illegible]	70.142	2.318E+01	68.473	2.172E+01
[illegible]	2.034E+01	62.684	2.051E+01	57.878	2.207E+01
52.483	2.363E+01	48.357	2.561E+01	44.411	2.790E+01
41.378	2.975E+01	39.392	2.966E+01	36.154	3.000E+01
[illegible]	3.131E+01	31.786	3.340E+01	30.263	3.587E+01
[illegible]	3.936E+01	27.959	4.308E+01	27.381	4.663E+01
26.785	5.038E+01	26.604	5.210E+01	26.317	4.527E+01
26.133	4.025E+01	25.706	4.294E+01	25.465	4.659E+01
24.435	5.270E+01	24.105	5.434E+01	23.886	5.849E+01
23.575	6.237E+01	23.686	7.210E+01	23.366	6.862E+01
23.161	7.218E+01	23.042	6.856E+01	22.572	7.409E+01
22.338	7.910E+01	22.599	8.316E+01	22.407	8.643E+01
22.235	9.006E+01	22.101	9.243E+01	21.917	9.176E+01
21.574	9.132E+01	21.432	8.897E+01	21.387	8.701E+01
21.226	8.521E+01	21.185	8.081E+01	21.174	7.650E+01
21.115	7.213E+01	21.075	6.833E+01	21.049	6.413E+01
21.020	6.000E+01	20.980	5.580E+01	20.947	5.149E+01
20.907	4.738E+01	20.864	3.934E+01	20.821	3.499E+01
20.821	3.072E+01	20.821	2.700E+01	20.821	2.272E+01
20.711	2.555E+01	20.518	2.894E+01	20.308	3.295E+01
19.993	3.733E+01	19.813	4.121E+01	19.730	4.395E+01
19.506	4.096E+01	19.567	3.904E+01	19.413	3.621E+01
19.203	3.896E+01	19.012	4.280E+01	18.813	4.666E+01
18.513	5.041E+01	18.054	5.361E+01	17.621	5.693E+01
17.337	6.049E+01	17.134	6.295E+01	16.842	6.388E+01
16.597	5.292E+01	16.458	6.119E+01	16.284	5.816E+01
16.035	5.548E+01	15.968	5.432E+01	15.817	5.620E+01
15.539	6.020E+01	15.472	6.399E+01	15.318	6.777E+01
15.113	7.167E+01	14.908	7.560E+01	14.581	7.608E+01

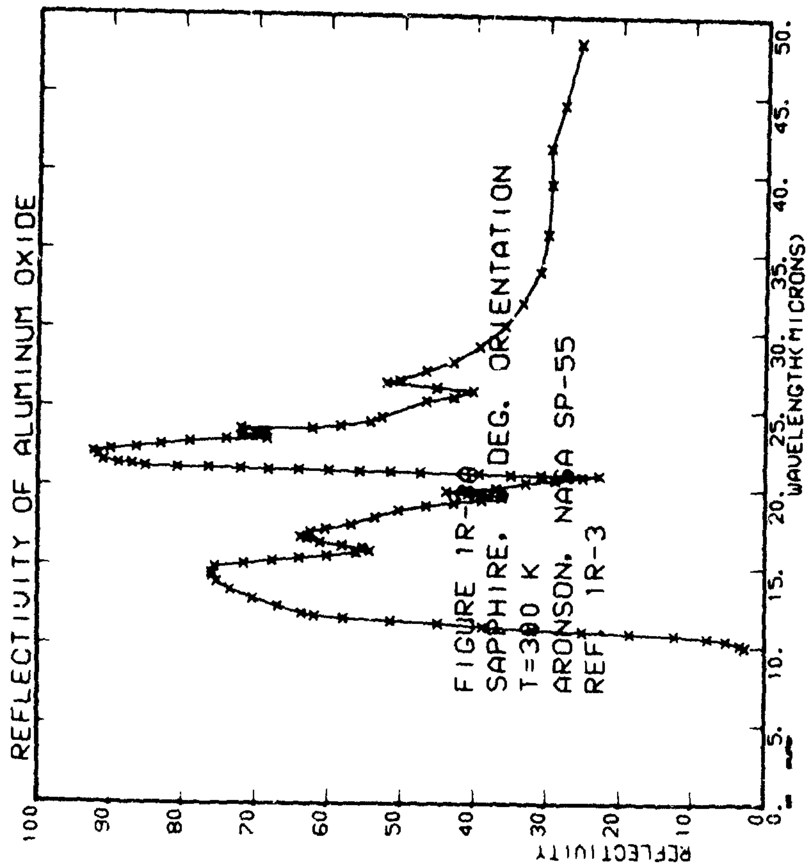
Aronson (Ref. 1 R-3)

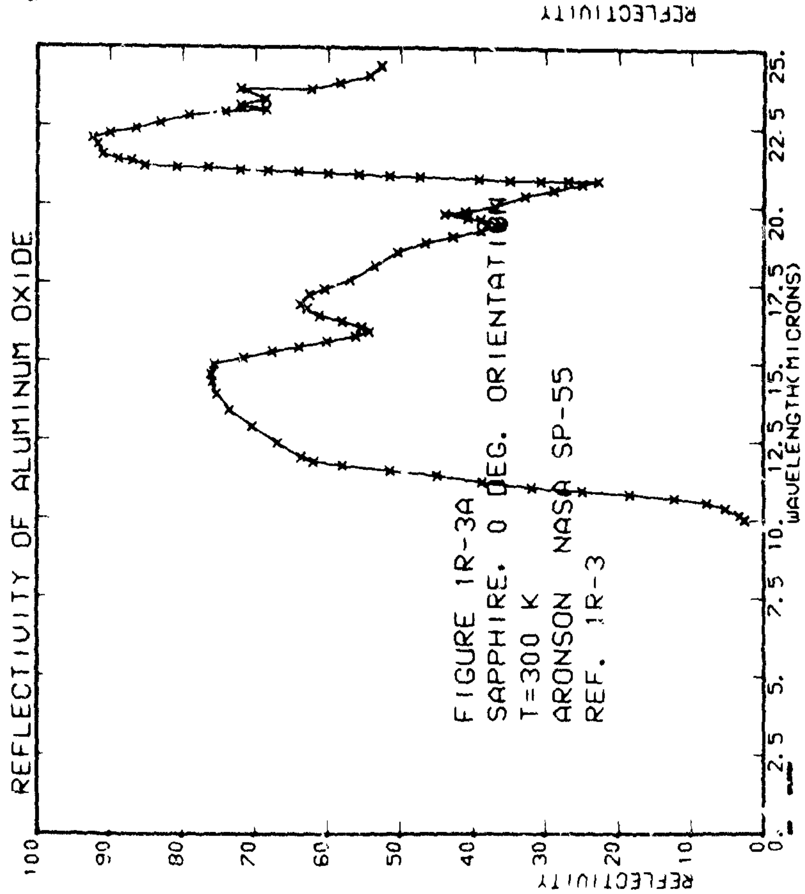
a. continued

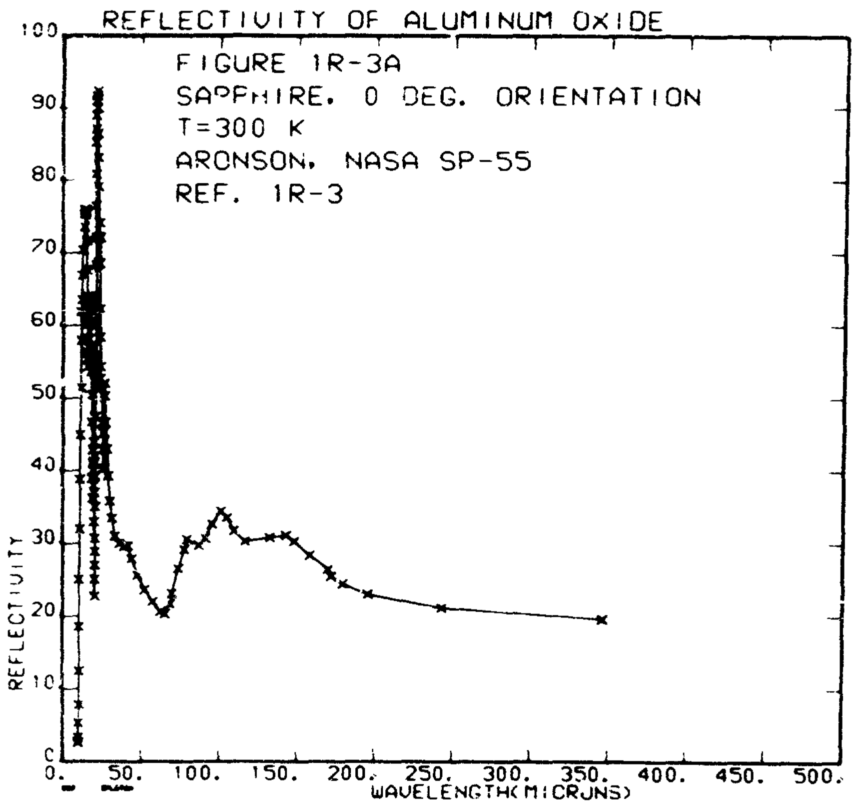
λ	R	λ	R	λ	R
14.351	7.592E+01	13.971	7.530E+01	13.471	7.353E+01
12.941	7.042E+01	12.417	6.693E+01	11.954	6.369E+01
11.813	6.197E+01	11.682	5.798E+01	11.532	5.141E+01
11.378	4.435E+01	11.173	3.886E+01	11.022	3.196E+01
10.311	2.503E+01	10.810	1.856E+01	10.696	1.240E+01
10.557	7.832E+00	10.396	5.344E+00	10.151	3.389E+00
10.323	2.626E+00				

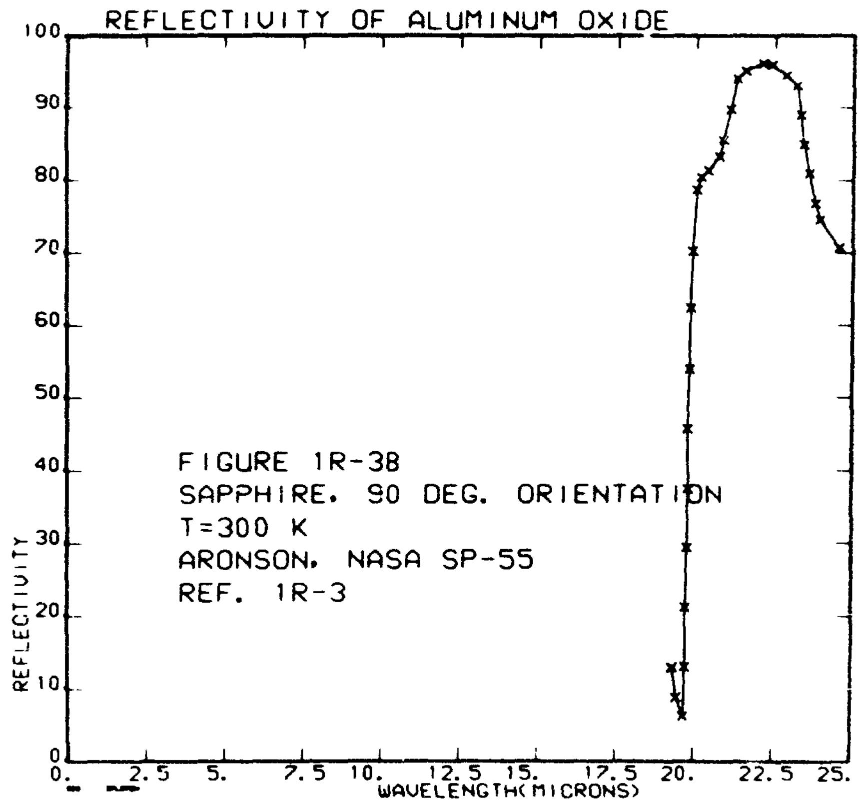
b. T = 300°K; 90° orientation

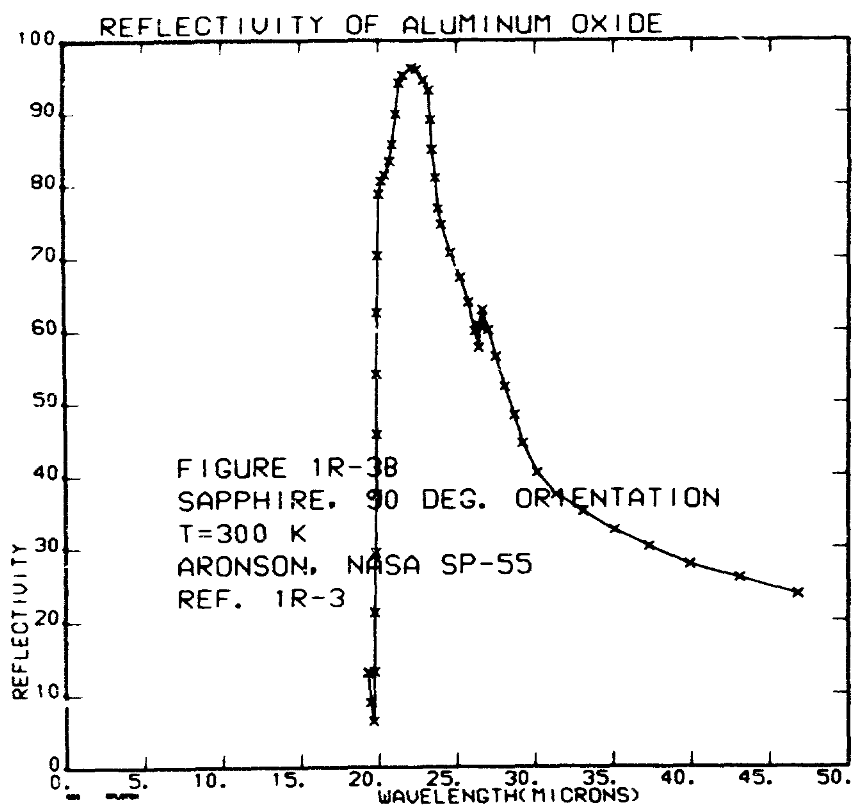
λ	R	λ	R	λ	R
95.791	2.105E+01	91.172	1.966E+01	86.978	1.961E+01
84.063	2.107E+01	81.553	2.204E+01	78.430	1.908E+01
76.812	1.724E+01	75.584	1.475E+01	72.765	1.312E+01
66.736	1.197E+01	63.811	1.213E+01	59.805	1.559E+01
55.813	1.916E+01	53.342	2.075E+01	50.722	2.148E+01
44.833	2.365E+01	43.140	2.595E+01	39.920	2.778E+01
37.286	3.011E+01	35.081	3.241E+01	33.053	3.502E+01
31.305	3.735E+01	30.121	4.041E+01	29.184	4.440E+01
28.655	4.835E+01	28.042	5.233E+01	27.467	5.649E+01
26.957	6.018E+01	26.622	6.287E+01	26.425	6.067E+01
26.345	5.767E+01	26.097	5.997E+01	25.717	6.386E+01
25.181	6.731E+01	24.576	7.079E+01	23.959	7.469E+01
23.798	7.684E+01	23.621	8.102E+01	23.434	8.494E+01
23.378	9.901E+01	23.204	9.309E+01	22.857	9.453E+01
22.404	9.602E+01	22.108	9.620E+01	21.571	9.521E+01
21.298	9.411E+01	21.097	9.988E+01	20.871	8.567E+01
20.738	8.337E+01	20.385	8.144E+01	20.170	8.057E+01
20.023	7.874E+01	19.915	7.033E+01	19.851	6.248E+01
19.841	5.406E+01	19.797	4.571E+01	19.800	3.748E+01
19.774	2.933E+01	19.744	2.116E+01	19.730	1.307E+01
19.687	6.261E+00	19.448	8.813E+00	19.336	1.297E+01

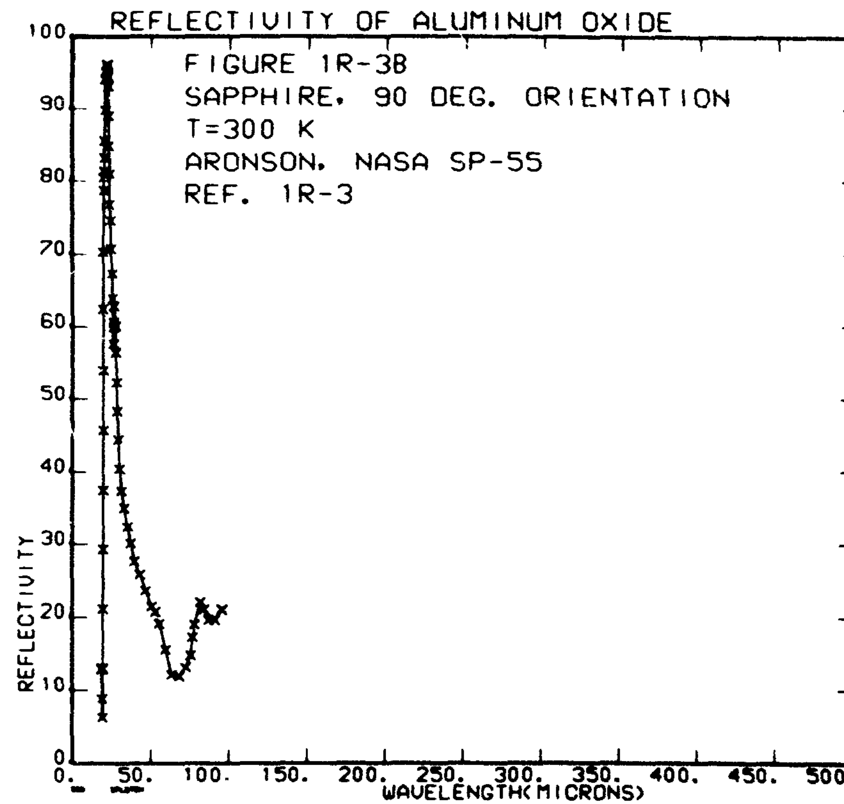

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-
SAPPHIRE, DEG. ORIENTATION
T=300 K
ARONSON, NASA SP-55
REF. 1R-3
REFLECTIVITY
100 90 80 70 60 50 40 30 20 10 0.
5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-3A
SAPPHIRE, 0 DEG. ORIENTATION
T=300 K
ARONSON NASA SP-55
REF. 1R-3
REFLECTIVITY
100 90 80 70 60 50 40 30 20 10 0.
2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-3A
SAPPHIRE. 0 DEG. ORIENTATION
T=300 K
ARONSON, NASA SP-55
REF. 1R-3
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0 10 20 30 40 50 60 70 80 90 100


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-3B
SAPPHIRE. 90 DEG. ORIENTATION
T=300 K
ARONSON, NASA SP-55
REF. 1R-3
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

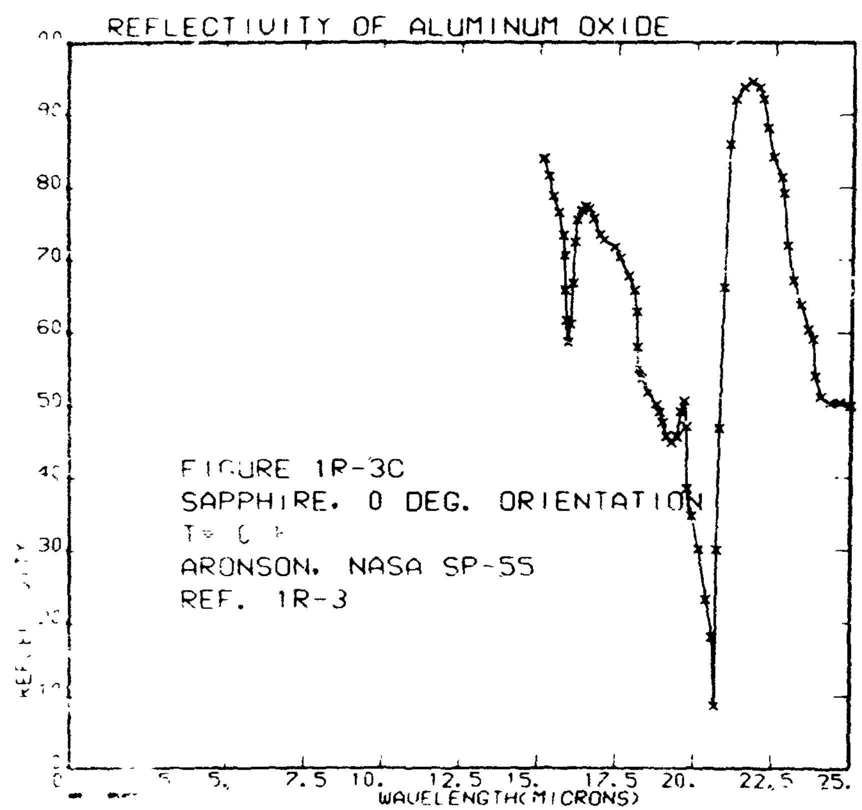

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-3B
SAPPHIRE. 90 DEG. ORIENTATION
T=300 K
ARONSON. NASA SP-55
REF. 1R-3
REFLECTIVITY
WAVELENGTH(MICRONS)

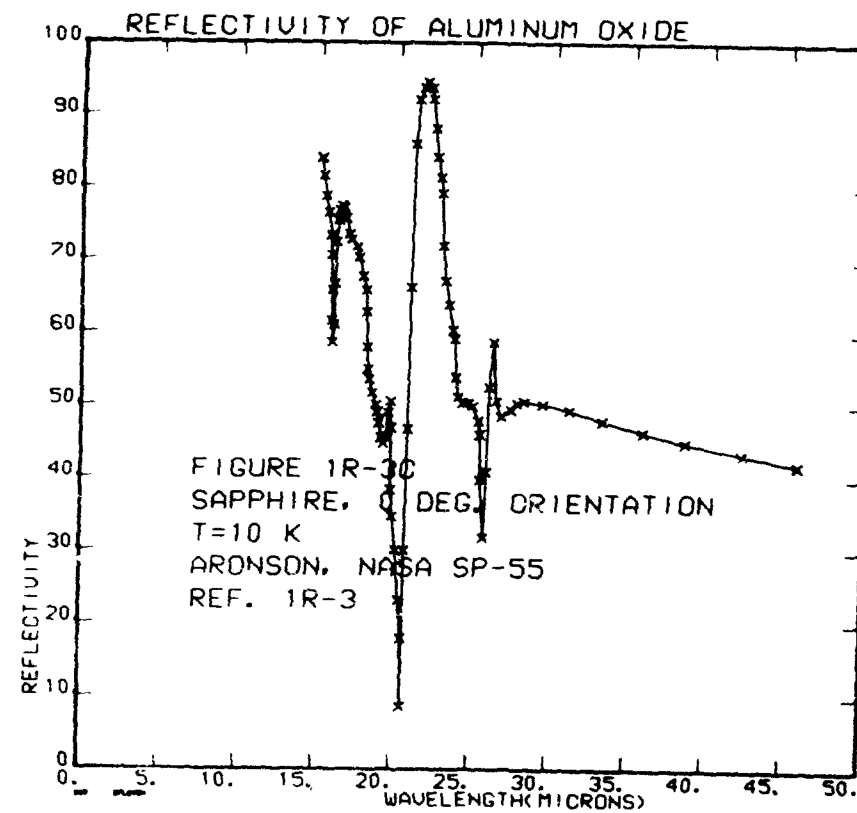

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-3B
SAPPHIRE. 90 DEG. ORIENTATION
T=300 K
ARONSON. NASA SP-55
REF. 1R-3
REFLECTIVITY
WAVELENGTH(MICRONS)

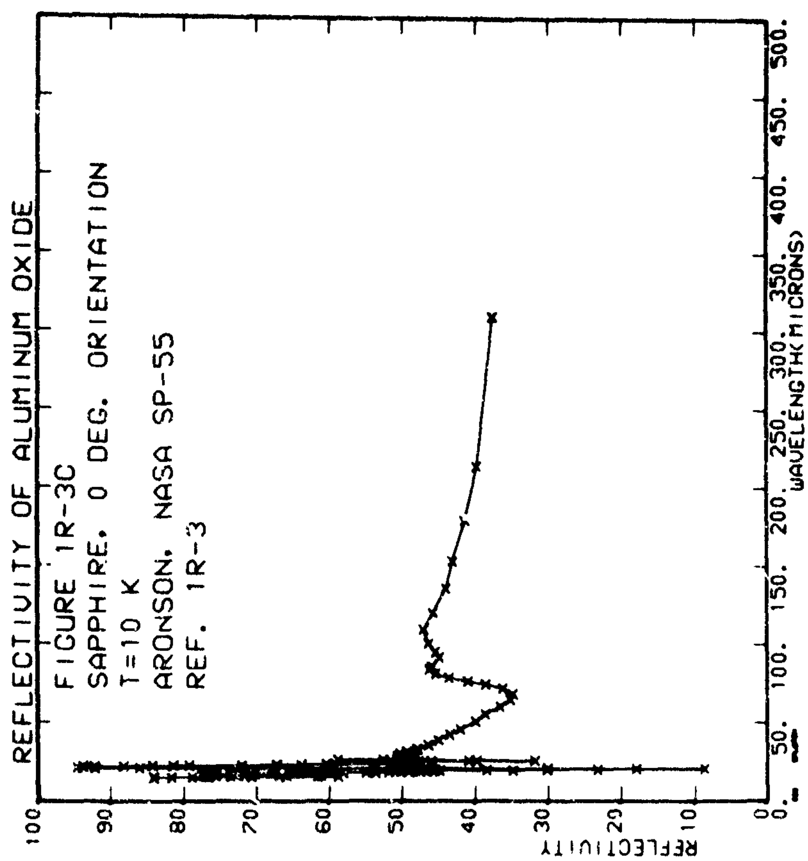
Aronson (Ref. 1R-3)

c. $T \leq 10^{o}K$; 0^{o} orientation.

λ	R	λ	R	λ	R
369.278	3.758E+01	213.144	3.976E+01	178.838	4.132E+01
152.856	4.302E+01	134.983	4.392E+01	119.522	4.575E+01
108.992	4.700E+01	100.418	4.636E+01	94.939	4.549E+01
90.963	4.490E+01	85.734	4.539E+01	83.705	4.624E+01
80.494	4.546E+01	78.305	4.351E+01	75.998	4.093E+01
74.399	3.859E+01	71.644	3.615E+01	68.209	3.478E+01
64.783	3.518E+01	60.273	3.650E+01	55.268	3.868E+01
56.613	3.998E+01	45.846	4.193E+01	42.345	4.341E+01
38.689	4.505E+01	35.904	4.647E+01	33.297	4.793E+01
31.216	4.938E+01	29.480	5.019E+01	28.290	5.062E+01
27.837	5.032E+01	27.480	4.930E+01	26.832	4.840E+01
26.483	5.062E+01	26.272	5.879E+01	26.041	5.262E+01
25.914	4.082E+01	25.772	3.181E+01	25.534	3.979E+01
25.449	4.600E+01	25.375	4.788E+01	24.979	4.998E+01
24.649	5.045E+01	24.323	5.032E+01	24.029	5.124E+01
23.858	5.391E+01	23.779	5.924E+01	23.644	6.047E+01
23.339	6.382E+01	23.125	6.722E+01	22.942	7.209E+01
22.812	7.920E+01	22.739	8.141E+01	22.465	8.423E+01
22.296	8.824E+01	22.129	9.224E+01	22.012	9.384E+01
21.757	9.462E+01	21.508	9.382E+01	21.271	9.214E+01
21.078	8.607E+01	20.936	6.630E+01	20.810	4.677E+01
20.732	3.006E+01	20.690	8.611E+00	20.605	1.790E+01
20.404	2.325E+01	20.170	3.011E+01	19.926	3.472E+01
19.773	3.341E+01	19.750	4.098E+01	19.697	5.064E+01
19.567	4.908E+01	19.461	4.558E+01	19.293	4.484E+01
19.101	4.550E+01	18.975	4.751E+01	18.887	4.904E+01
18.793	5.016E+01	18.501	5.188E+01	18.321	5.364E+01
18.229	5.498E+01	18.172	5.803E+01	18.136	6.287E+01
18.056	6.590E+01	17.854	6.787E+01	17.574	7.037E+01
17.398	7.180E+01	17.068	7.286E+01	16.926	7.353E+01
16.728	7.570E+01	16.585	7.709E+01	16.470	7.746E+01
16.331	7.685E+01	16.208	7.551E+01	16.136	7.252E+01
16.079	5.685E+01	16.020	6.115E+01	15.942	5.876E+01
15.887	6.161E+01	15.846	6.596E+01	15.798	7.063E+01
15.750	7.345E+01	15.611	7.653E+01	15.444	7.884E+01
15.278	8.160E+01	15.132	3.408E+01		


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-3C
SAPPHIRE, 0 DEG. ORIENTATION
ARONSON, NASA SP-55
REF. 1R-3
WAVELENGTH(MICRONS)
80
70
60
50
30
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-3C
SAPPHIRE, DEG. ORIENTATION
T=10 K
ARONSON, NASA SP-55
REF. 1R-3
REFLECTIVITY
WAVELENGTH(MICRONS)
100
90
80
70
60
50
40
30
20
10
0
0.
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-3C
SAPPHIRE, 0 DEG. ORIENTATION
T=10 K
ARONSON, NASA SP-55
REF. 1R-3
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0 10 20 30 40 50 60 70 80 90 100

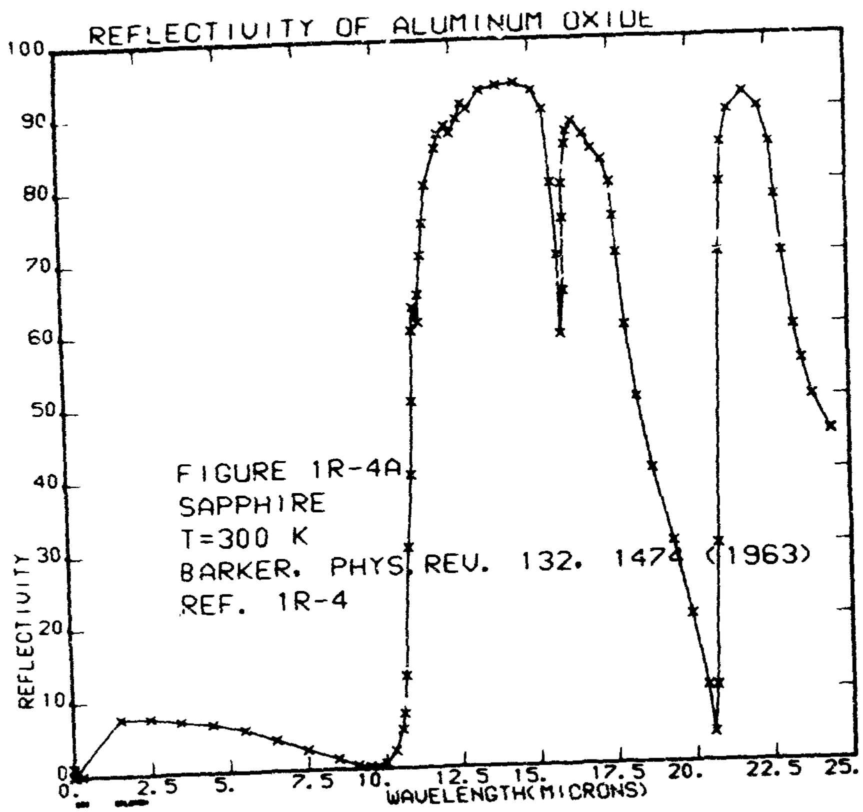
Barker (Ref. IR-4)

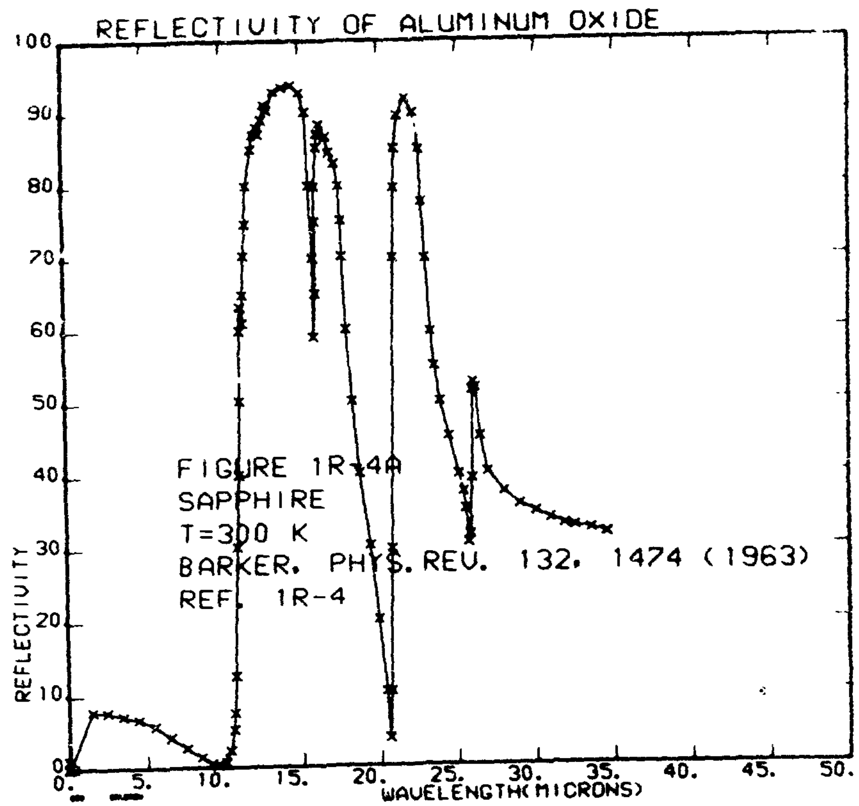
The reflectivity of sapphire and ruby were studied from 1 - 35μ using a prism spectrometer. It was determined that the presence of chromium in the ruby was indetectable in the infrared to 2.4×10^{20} ions/cm^3, but that crystal orientation was extremely important. Reflectivities for the ordinary ray (E ⊥ C axis) and the extraordinary ray (E ∥ C axis) are included, and the effect on forbidden phonon modes of etching several microns of surface from the crystal using molten boron oxide and lead oxide was studied. No error analysis or bandpass was given. The temperature is unspecified (room temperature). Data were digitized from points.

These data were selected in part to construct the representative curve for sapphire in Section I, Figure I - 1.6.

a. Ordinary ray reflectivity, Linde flame fusion white sapphire.

λ	R	λ	R	λ	R	λ	R
3.[illegible]	[illegible]	4.[illegible]55	6.[illegible]E+00	1.524	7.773E+00	2.487	7.627E+00
[illegible]	[illegible]	6.[illegible]90	1.[illegible]E+00	5.500	5.548E+00	6.501	4.148E+00
10.0[illegible]5	[illegible].710E-01	10.3[illegible]	2.38[illegible]E+00	9.099	[illegible].531E-01	9.51[illegible]	3.785E-01
10.[illegible]19	1.251E+01	10.[illegible]63	3.025E+01	10.558	[illegible].138E+00	10.640	7.482E+00
11.122	[illegible].001E+01	11.15[illegible]	5.33[illegible]E+01	11.007	4.013E+01	11.057	5.034E+01
11.4[illegible]	[illegible]	11.503	7.[illegible]E+01	11.327	6.114E+01	11.345	6.503E+01
12.[illegible]90	[illegible].711E+01	12.322	[illegible].826E+01	11.638	8.014E+01	11.973	8.511E+01
12.339	9.125E+01	13.012	9.340E+01	12.434	8.717E+01	12.681	8.911E+01
14.[illegible]	9.79[illegible]E+01	15.081	9.29[illegible]E+01	13.409	9.308E+01	13.972	9.365E+01
15.[illegible]99	[illegible].001E+01	15.495	5.910E+01	15.401	9.028E+01	15.623	8.010E+01
15.979	7.999E+01	16.121	8.53[illegible]E+01	15.979	6.512E+01	15.982	7.511E+01
15.597	3.672E+01	16.330	3.[illegible]58E+01	16.153	8.717E+01	16.331	8.859E+01
[illegible]	[illegible].321E+01	1[illegible]	7.02[illegible]E+01	17.249	8.315E+01	17.513	8.009E+01
18.[illegible]	[illegible].034E+01	19.370	3.037E+01	17.937	6.013E+01	18.257	5.026E+01
20.[illegible]82	3.799E+00	20.689	1.[illegible]32E+01	19.942	2.016E+01	20.375	1.031E+01
21.[illegible]	[illegible].379E+01	21.058	8.[illegible]03E+01	20.739	2.988E+01	20.925	7.007E+01
22.[illegible]	3.[illegible]01E+01	22.515	8.5[illegible]E+01	21.291	8.957E+01	21.776	9.206E+01
23.313	[illegible].372E+01	23.531	5.5[illegible]E+01	22.754	7.775E+01	22.349	5.997E+01
25.[illegible]3	[illegible].001E+01	25.358	3.7[illegible]E+01	23.665	5.209E+01	24.436	4.525E+01
25.[illegible]7	3.175E+01	25.924	3.94[illegible]E+01	25.523	3.516E+01	25.693	3.053E+01
26.135	[illegible].195E+01	26.[illegible]01	4.319E+01	25.927	5.154E+01	25.991	5.273E+01
28.955	3.576E+01	30.018	3.471E+01	26.901	4.037E+01	27.980	3.756E+01
32.4[illegible]	3.276E+01	33.301	3.233E+01	30.942	3.381E+01	31.344	3.309E+01
				34.532	3.178E+01		


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-4A
SAPPHIRE
T=300 K
BARKER. PHYS. REV. 132. 1474 (1963)
REF. 1R-4
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-4A
SAPPHIRE
T=300 K
BARKER. PHYS. REV. 132. 1474 (1963)
REF. 1R-4
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

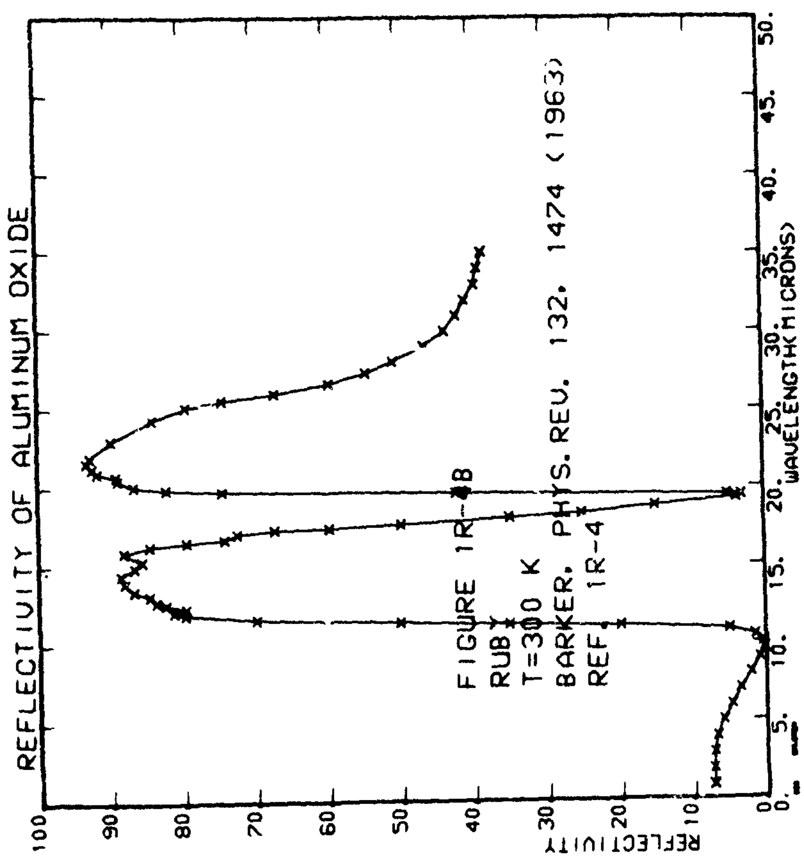
Barker (Ref. 1R-4)

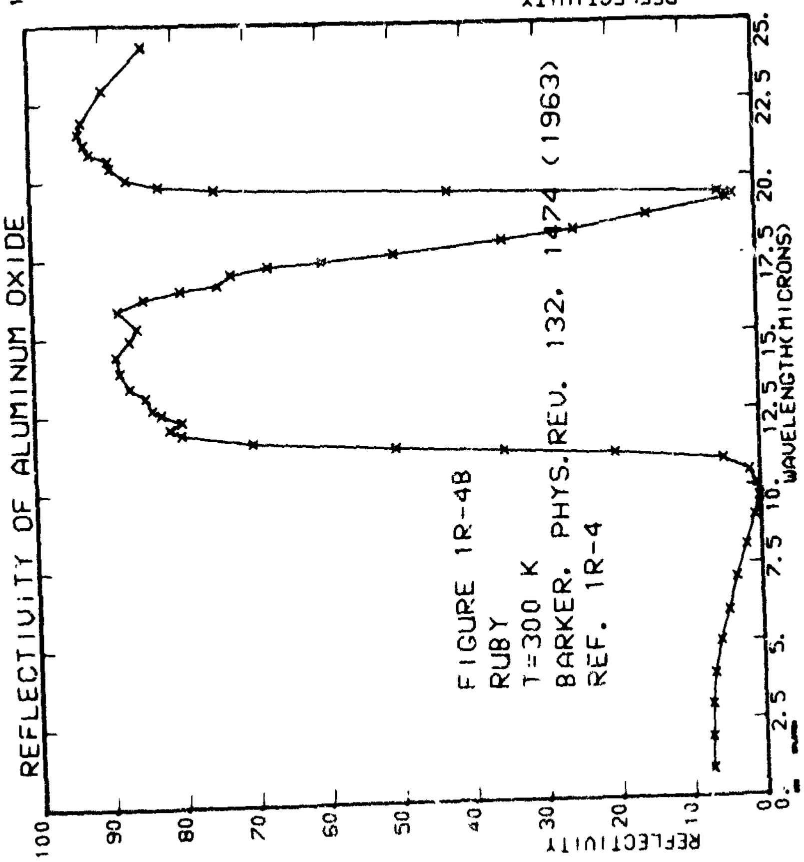
b. Extraordinary ray reflectivity, Linde fusion ruby, 1.8 x 10^{18} chromium ions/cm^3.

λ	R	λ	R	λ	R	λ	R
.890	7.416E+00	1.905	7.319E+00	2.957	7.191E+00	3.948	6.879E+00
5.006	5.901E+00	5.996	4.695E+00	7.054	3.518E+00	8.082	2.170E+00
9.077	9.362E-01	9.627	2.937E-01	10.044	4.397E-01	10.476	1.433E+00
10.894	4.336E+00	11.104	1.963E+01	11.224	3.511E+01	11.367	5.019E+01
11.577	5.396E+01	11.895	7.977E+01	12.074	8.134E+01	12.322	7.950E+01
12.550	8.247E+01	12.710	8.372E+01	13.119	8.468E+01	13.411	8.682E+01
13.963	9.311E+01	14.442	8.865E+01	14.942	8.675E+01	15.327	8.566E+01
15.383	9.420E+01	15.748	8.465E+01	16.501	7.953E+01	16.585	7.431E+01
17.013	7.255E+01	17.268	6.734E+01	17.388	5.987E+01	17.603	4.991E+01
18.013	3.491E+01	18.338	2.492E+01	18.776	1.489E+01	19.289	3.745E+00
19.411	3.064E+00	19.484	5.073E+00	19.609	4.235E+01	19.735	7.455E+01
19.874	8.222E+01	20.087	8.673E+01	20.466	8.898E+01	20.722	8.913E+01
20.317	9.177E+01	21.211	9.244E+01	21.552	9.327E+01	21.925	9.270E+01
22.956	8.989E+01	24.327	8.416E+01	25.117	7.952E+01	25.533	7.459E+01
25.964	5.724E+01	26.623	5.973E+01	27.279	5.450E+01	27.999	5.082E+01
29.042	4.555E+01	29.977	4.367E+01	30.983	4.198E+01	31.981	4.074E+01
32.378	3.640E+01	34.014	3.901E+01	35.015	3.840E+01		

c. Ordinary ray reflectivity, Meller sapphire, before etch.

λ	R	λ	R	λ	R	λ	R
15.221	8.318E+01	15.293	8.238E+01	15.394	8.088E+01	15.489	7.919E+01
[illegible]	7.720E+01	15.644	7.551E+01	15.711	7.349E+01	15.753	7.163E+01
15.760	6.972E+01	15.775	6.769E+01	15.791	6.589E+01	15.801	6.517E+01
15.857	6.482E+01	15.936	6.539E+01	15.940	6.708E+01	15.978	6.865E+01
[illegible]	6.954E+01	16.041	7.018E+01	16.157	7.037E+01	16.246	6.998E+01
16.397	5.854E+01	16.583	5.721E+01	16.738	6.556E+01	16.951	6.424E+01
17.122	5.440E+01	17.260	6.467E+01	17.446	6.487E+01	17.570	6.459E+01
17.521	5.774E+01	17.672	6.208E+01	17.725	6.030E+01	17.769	5.887E+01
17.785	5.794E+01	17.923	5.694E+01	17.877	5.531E+01	17.970	5.310E+01
[illegible]	5.117E+01	18.208	4.854E+01	20.959	6.286E+01	20.959	7.009E+01
20.373	7.353E+01	21.002	7.504E+01	21.094	7.779E+01	21.165	7.981E+01
21.255	8.184E+01	21.351	8.367E+01	21.417	8.456E+01	21.548	8.505E+01
[illegible]	8.456E+01	21.798	8.358E+01	21.977	8.181E+01	22.154	7.982E+01
22.323	7.791E+01	22.499	7.610E+01	22.671	7.421E+01	22.790	7.207E+01
22.485	7.007E+01	23.011	5.799E+01	23.107	6.588E+01	23.191	6.384E+01
23.249	6.192E+01	23.315	6.302E+01	23.389	5.715E+01		


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-4B
RUBY
T=300 K
BARKER. PHYS. REV. 132. 1474 (1963)
REF. 1R-4
REFLECTIVITY
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-4B
RUBY
T=300 K
BARKER. PHYS. REV. 132. 1474 (1963)
REF. 1R-4
REFLECTIVITY
WAVELENGTH(MICRONS)

Barker (Ref. 1R-4)

d. Ordinary ray reflectivity, Meller sapphire, after etch.

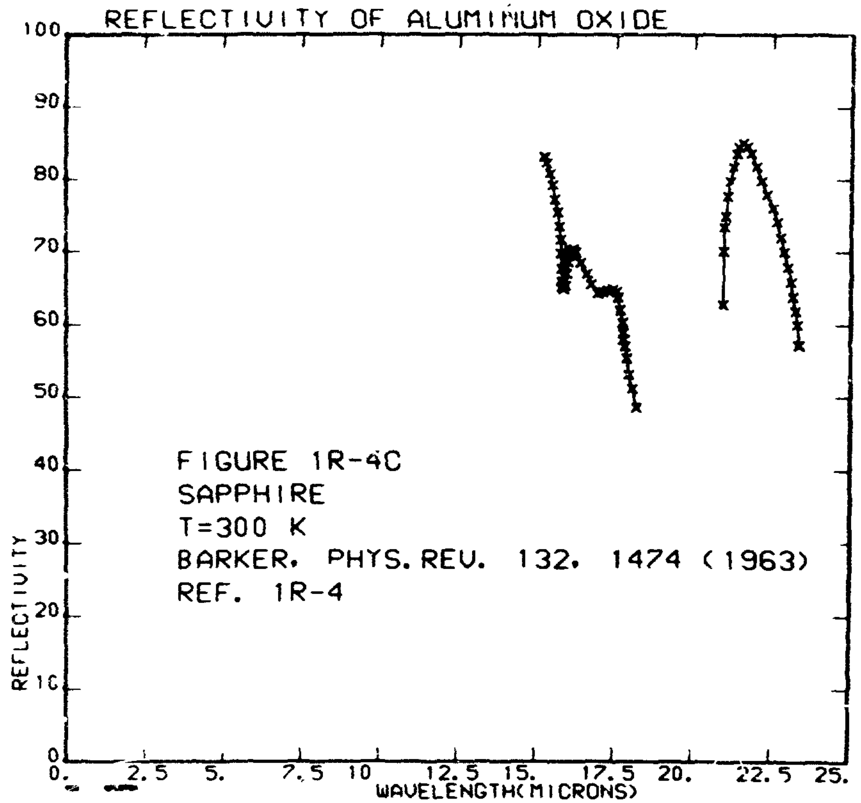
λ	R	λ	R	λ	R	λ	R
15.139	9.777E+01	15.290	9.653E+01	15.44[illegible]	8.448E+01	15.533	8.269E+01
15.50[illegible]	9.074E+01	15.556	7.753E+01	15.716	7.342E+01	15.758	6.622E+01
15.773	5.907E+01	15.808	5.622E+01	15.835	5.409E+01	15.886	5.329E+01
15.937	5.362E+01	15.970	5.482E+01	15.978	5.909E+01	16.022	6.478E+01
16.041	7.026E+01	16.059	7.372E+01	16.101	7.799E+01	16.185	8.127E+01
16.265	8.320E+01	15.379	8.470E+01	16.484	8.557E+01	16.533	8.611E+01
16.826	8.534E+01	17.005	8.525E+01	17.164	9.579E+01	17.280	8.523E+01
17.375	9.396E+01	17.439	8.174E+01	17.495	7.869E+01	17.574	7.568E+01
17.538	7.215E+01	17.684	6.775E+01	17.736	6.411E+01	17.798	5.989E+01
17.851	5.525E+01	17.904	5.424E+01	17.938	5.321E+01	20.962	6.282E+01
20.902	7.068E+01	20.962	7.532E+01	21.002	7.853E+01	21.080	8.142E+01
21.173	8.757E+01	21.305	8.561E+01	21.462	8.742E+01	21.649	8.839E+01
21.312	8.977E+01	21.946	8.990E+01	22.129	8.874E+01	22.277	8.839E+01
22.421	8.763E+01	22.504	8.700E+01	22.577	8.577E+01	22.628	8.308E+01
22.559	7.939E+01	22.755	7.574E+01	22.821	7.104E+01	22.917	6.741E+01
22.995	5.409E+01	23.105	6.085E+01	23.139	5.817E+01	23.284	5.555E+01
23.377	5.407E+01						

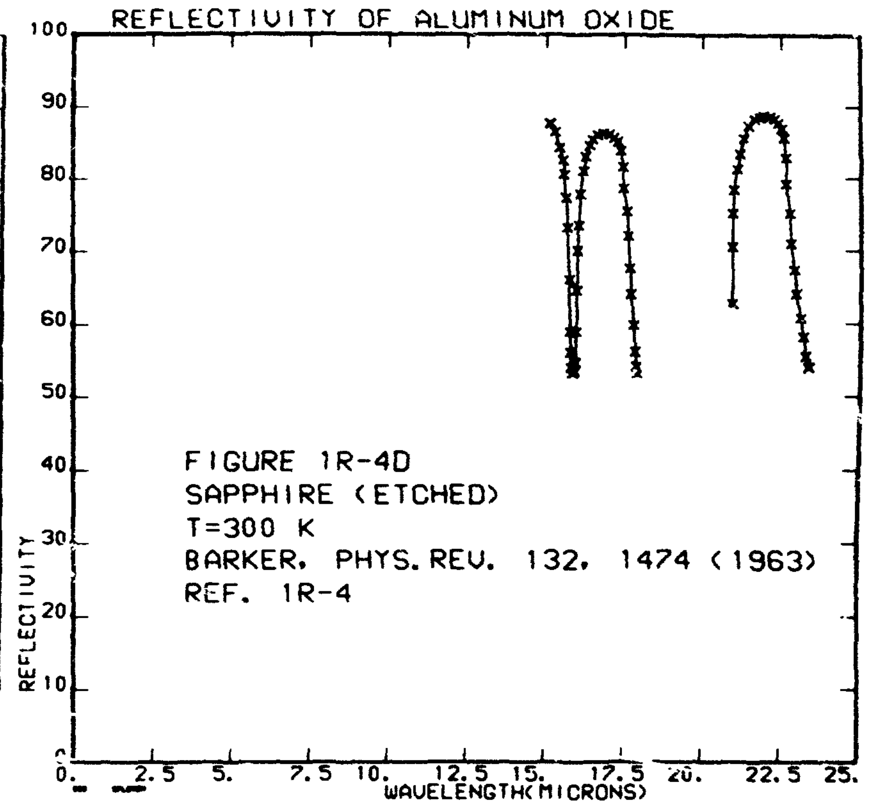
e. Ordinary ray reflectivity, Meller sapphire, after etch and 15μ grit abrasion.

λ	R	λ	R	λ	R	λ	R
16.105	6.916E+01	16.244	6.611E+01	16.368	6.375E+01	16.505	6.064E+01
16.643	5.775E+01	16.801	5.506E+01	16.930	5.230E+01	17.053	4.928E+01
17.171	4.506E+01	17.302	4.344E+01	17.479	4.117E+01	17.784	3.925E+01
19.036	3.912E+01	20.939	6.923E+01	20.983	6.981E+01	21.354	7.222E+01
21.178	7.456E+01	21.311	7.650E+01	21.363	7.708E+01	21.529	7.749E+01
21.692	7.719E+01	21.883	7.549E+01	22.070	7.320E+01	22.181	7.095E+01
22.265	6.872E+01	22.377	6.596E+01	22.491	6.342E+01	22.617	6.115E+01
22.743	5.879E+01	22.875	5.652E+01	23.059	5.439E+01	23.293	5.247E+01

f. Ordinary ray reflectivity, Meller sapphire, after etch and 6μ grit abrasion.

λ	R	λ	R	λ	R	λ	R
16.169	5.894E+01	16.366	6.512E+01	16.552	6.274E+01	16.721	5.959E+01
16.934	5.620E+01	17.107	5.465E+01	17.280	5.517E+01	17.459	5.792E+01
17.557	3.897E+01	17.712	5.775E+01	17.861	5.464E+01	20.933	7.087E+01
21.065	7.209E+01	21.101	7.474E+01	21.196	7.904E+01	21.342	8.090E+01
21.447	8.132E+01	21.565	8.158E+01	21.727	8.121E+01	21.833	8.056E+01
22.028	7.757E+01	22.194	7.429E+01	22.416	7.066E+01	22.520	6.892E+01
22.705	5.734E+01	22.804	6.653E+01	22.926	6.532E+01	23.004	6.400E+01


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-4C
SAPPHIRE
T=300 K
BARKER, PHYS.REV. 132, 1474 (1963)
REF. 1R-4
REFLECTIVITY
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-4D
SAPPHIRE (ETCHED)
T=300 K
BARKER, PHYS.REV. 132, 1474 (1963)
REF. 1R-4
REFLECTIVITY
WAVELENGTH(MICRONS)

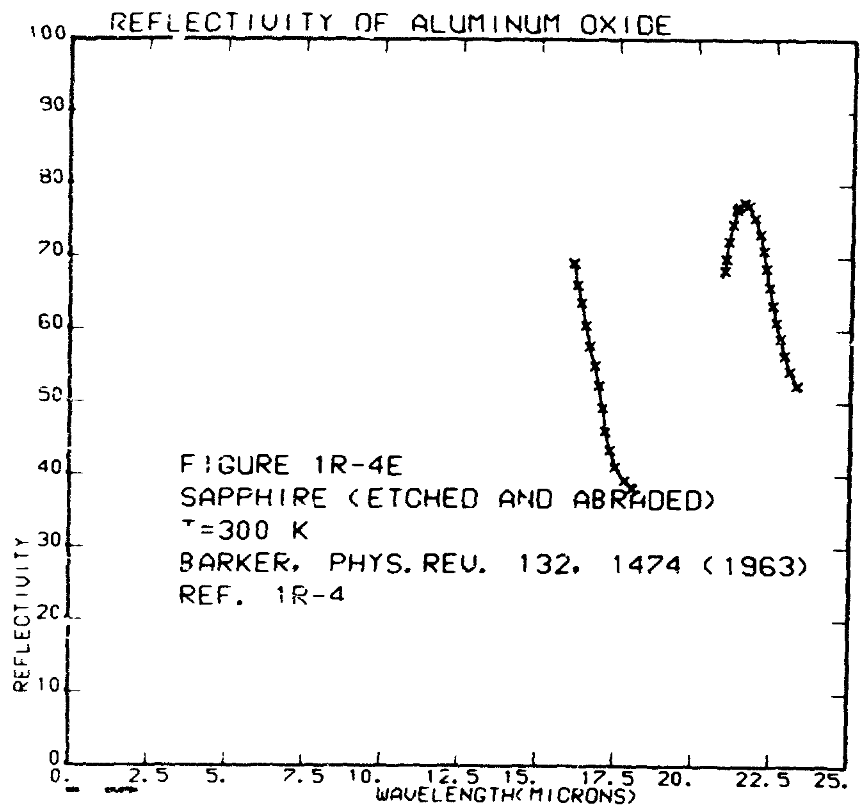


FIGURE 1R-4E
SAPPHIRE (ETCHED AND ABRADED)
T=300 K
BARKER, PHYS.REV. 132, 1474 (1963)
REF. 1R-4

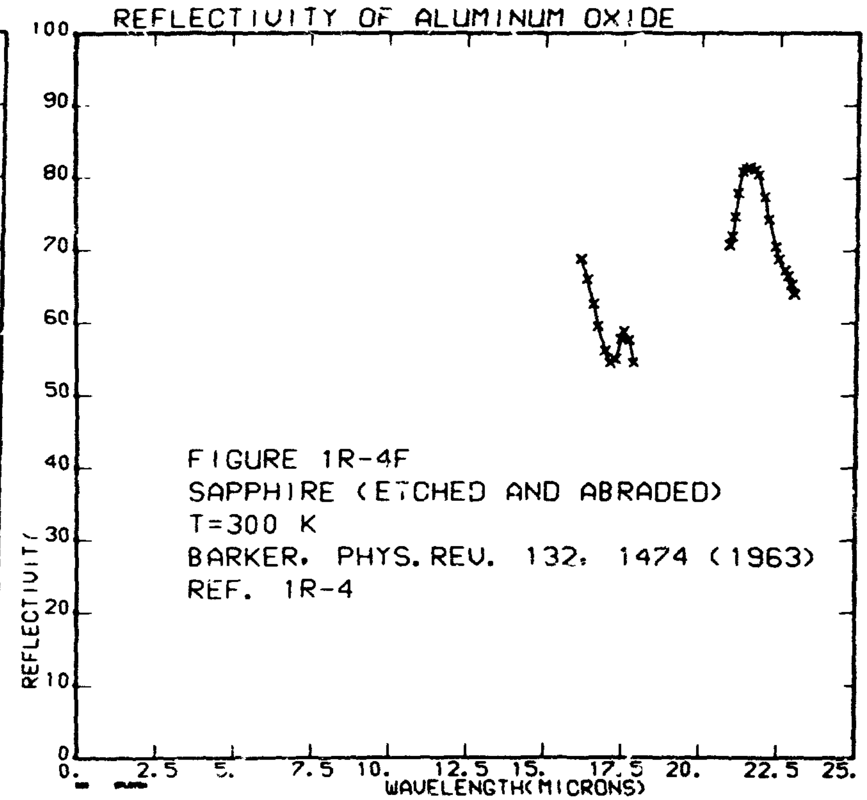


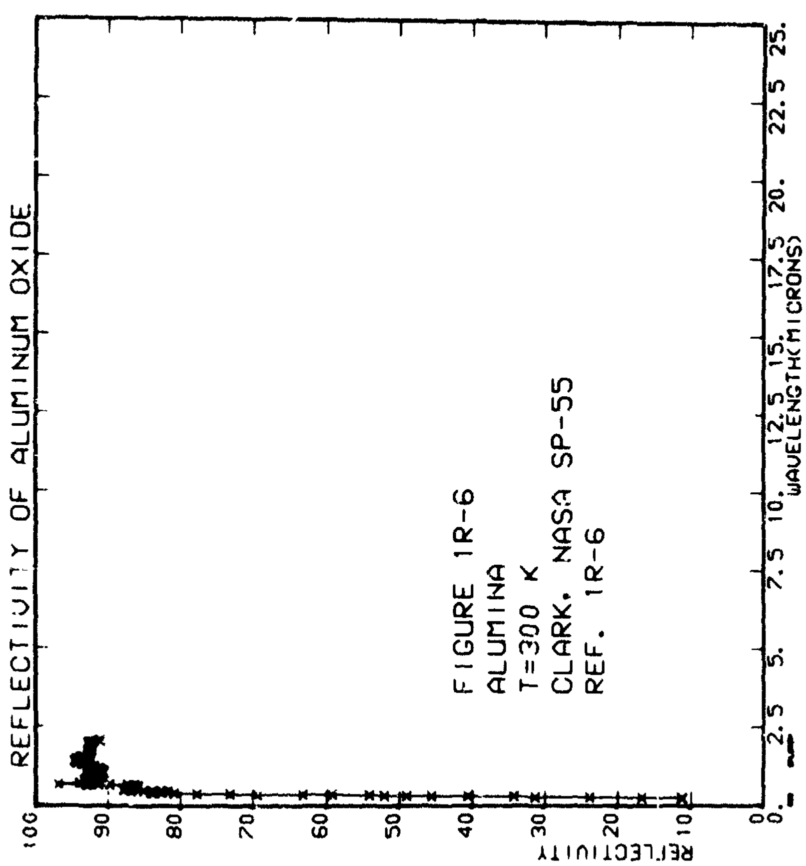
FIGURE 1R-4F
SAPPHIRE (ETCHED AND ABRADED)
T=300 K
BARKER, PHYS.REV. 132, 1474 (1963)
REF. 1R-4

Clark (Ref. 1R-6)

A Cary 14M spectrophotometer was used to measure the reflectance of fine grained, 99 + percent pure alumina with a porosity of 36 percent. No error analysis or spectral bandpass is given. Data were digitized from a continuous line.

These data were selected in part to construct the representative curve in Section I, Figure I - 1.6.

λ	R	λ	R	λ	R	λ	R
.259	11.211	.271	16.816	.281	23.946	.292	31.436
.299	34.308	.304	40.632	.311	45.658	.313	49.009
.333	52.159	.343	54.139	.350	59.288	.356	63.228
.364	69.454	.375	73.245	.390	77.781	.409	80.941
.429	84.034	.439	83.647	.447	82.655	.455	81.832
.468	82.672	.483	85.076	.495	86.824	.510	87.933
.528	87.654	.556	86.824	.584	86.370	.612	85.950
.632	83.832	.651	86.403	.665	87.361	.675	89.815
.683	92.971	.691	96.910	.699	93.990	.733	91.409
.714	91.392	.740	92.462	.768	93.073	.786	93.192
.813	93.039	.844	92.988	.879	92.598	.910	92.309
.942	92.241	.971	92.615	.995	92.377	1.018	91.562
1.041	91.138	1.061	90.645	1.104	90.696	1.136	91.002
1.181	91.367	1.228	92.003	1.290	92.699	1.323	93.684
1.364	94.363	1.402	94.754	1.441	94.448	1.491	94.312
1.533	93.837	1.572	93.447	1.605	92.767	1.665	92.716
1.715	92.530	1.769	92.428	1.837	92.445	1.905	92.445
1.957	92.581	1.998	92.801	2.030	92.683	2.062	92.224
2.094	91.138						


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-6
ALUMINA
T=300 K
CLARK, NASA SP-55
REF. 1R-6
REFLECTIVITY
100
90
80
70
60
50
40
30
20
10
0
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

Gervais (Ref. 1R-7)

The reflection spectrum of sapphire ($E \perp C$) was studied from 9μ to 33μ over a temperature range of 960°K to 2070°K using a Perkin-Elmer 12C spectrometer with a 2 to 4 cm^{-1} bandpass. Samples were heated by furnace and by laser radiation at 944 cm^{-1}. The measurements have an estimated precision of 1 percent, and the largest temperature uncertainty is ± 50°K at 1550°K. Data were digitized from continuous lines.

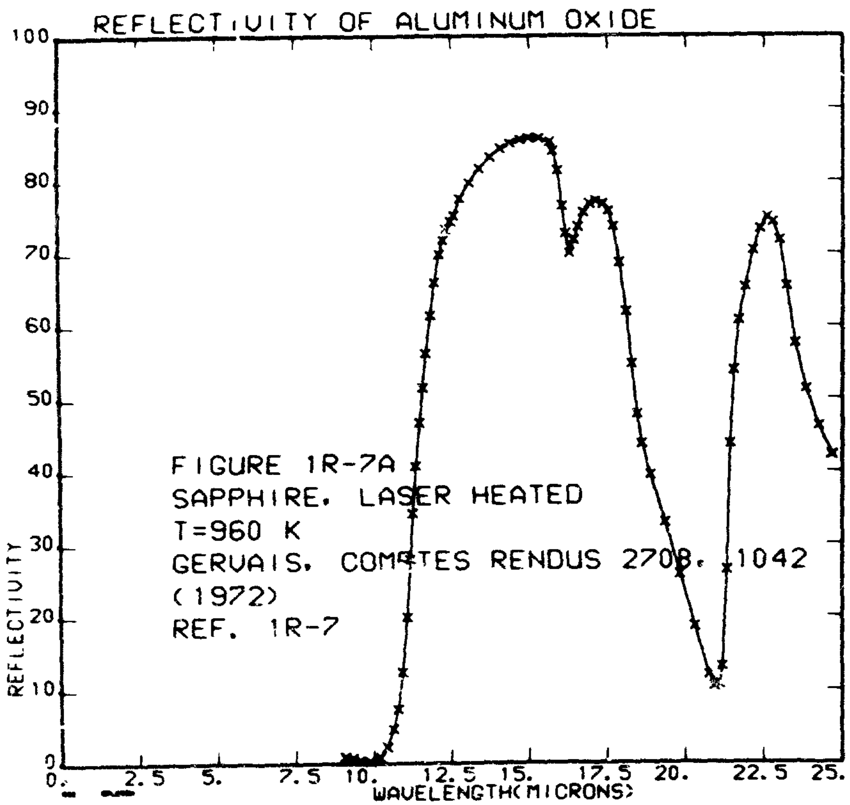
Agreement of these data with the representative curve given in Section I - 1.6 is generally good.

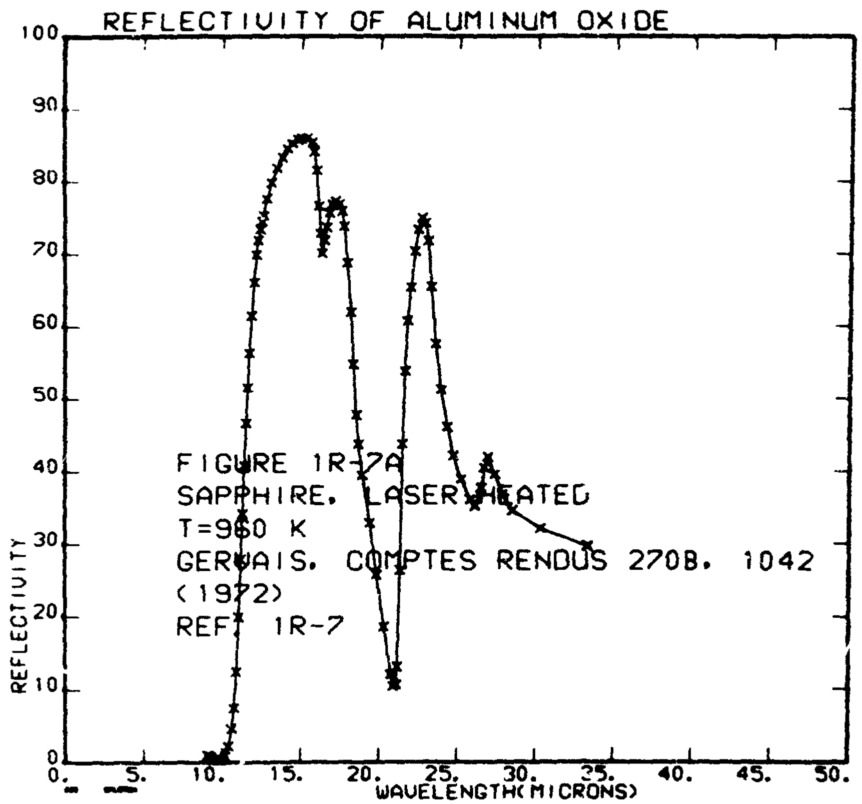
a. T = 960°K ± 20°, laser heated.

λ	R
3.330E+01	2.963E+01
2.780E+01	3.589E+01
2.665E+01	4.056E+01
2.578E+01	3.613E+01
2.427E+01	4.628E+01
2.323E+01	6.554E+01
2.260E+01	7.500E+01
2.191E+01	6.545E+01
2.143E+01	4.382E+01
2.110E+01	1.078E+01
2.032E+01	1.861E+01
1.887E+01	3.957E+01
1.828E+01	5.482E+01
1.768E+01	7.379E+01
1.714E+01	7.737E+01
1.656E+01	7.373E+01
1.616E+01	7.279E+01
1.577E+01	8.418E+01
1.498E+01	8.594E+01
1.409E+01	8.449E+01
1.307E+01	7.983E+01
1.247E+01	7.450E+01
1.210E+01	6.930E+01
1.169E+01	5.637E+01
1.137E+01	4.081E+01
1.108E+01	1.390E+01
1.063E+01	4.648E+00
9.876E+00	3.398E-01
9.397E+00	9.401E-01
1.035E+01	1.305E+00
1.011E+01	4.586E-01
9.782E+00	1.540E-01
9.428E+00	3.858E-01
9.167E+00	7.114E-01

λ	R
3.027E+01	3.210E+01
2.731E+01	3.965E+01
2.645E+01	3.774E+01
2.519E+01	3.893E+01
2.385E+01	5.134E+01
2.300E+01	7.188E+01
2.239E+01	7.347E+01
2.172E+01	6.082E+01
2.133E+01	2.642E+01
2.094E+01	1.041E+01
1.983E+01	2.589E+01
1.861E+01	4.387E+01
1.810E+01	6.204E+01
1.753E+01	7.598E+01
1.693E+01	7.696E+01
1.644E+01	7.193E+01
1.605E+01	7.663E+01
1.565E+01	8.544E+01
1.472E+01	8.576E+01
1.375E+01	8.332E+01
1.279E+01	7.761E+01
1.235E+01	7.348E+01
1.196E+01	6.611E+01
1.158E+01	5.165E+01
1.127E+01	3.429E+01
1.094E+01	1.245E+01
1.043E+01	2.194E+00
9.550E+00	4.178E-01
1.032E+01	1.027E+00
1.002E+01	2.967E-01
9.690E+00	1.870E-01
9.324E+00	5.672E-01
9.107E+00	7.988E-01

λ	R
2.847E+01	3.467E+01
2.689E+01	4.208E+01
2.609E+01	3.526E+01
2.469E+01	4.225E+01
2.352E+01	5.760E+01
2.280E+01	7.429E+01
2.216E+01	7.043E+01
2.155E+01	5.391E+01
2.118E+01	1.311E+01
2.076E+01	1.208E+01
1.937E+01	3.294E+01
1.847E+01	4.787E+01
1.768E+01	6.880E+01
1.735E+01	7.696E+01
1.673E+01	7.570E+01
1.628E+01	7.018E+01
1.591E+01	8.155E+01
1.531E+01	8.597E+01
1.438E+01	8.523E+01
1.341E+01	8.186E+01
1.258E+01	7.538E+01
1.223E+01	7.195E+01
1.182E+01	6.154E+01
1.148E+01	4.674E+01
1.119E+01	2.792E+01
1.079E+01	7.434E+00
1.020E+01	8.357E-01
9.340E+00	6.964E-01
1.023E+01	7.326E-01
9.882E+00	1.804E-01
9.543E+00	2.782E-01
9.226E+00	6.267E-01

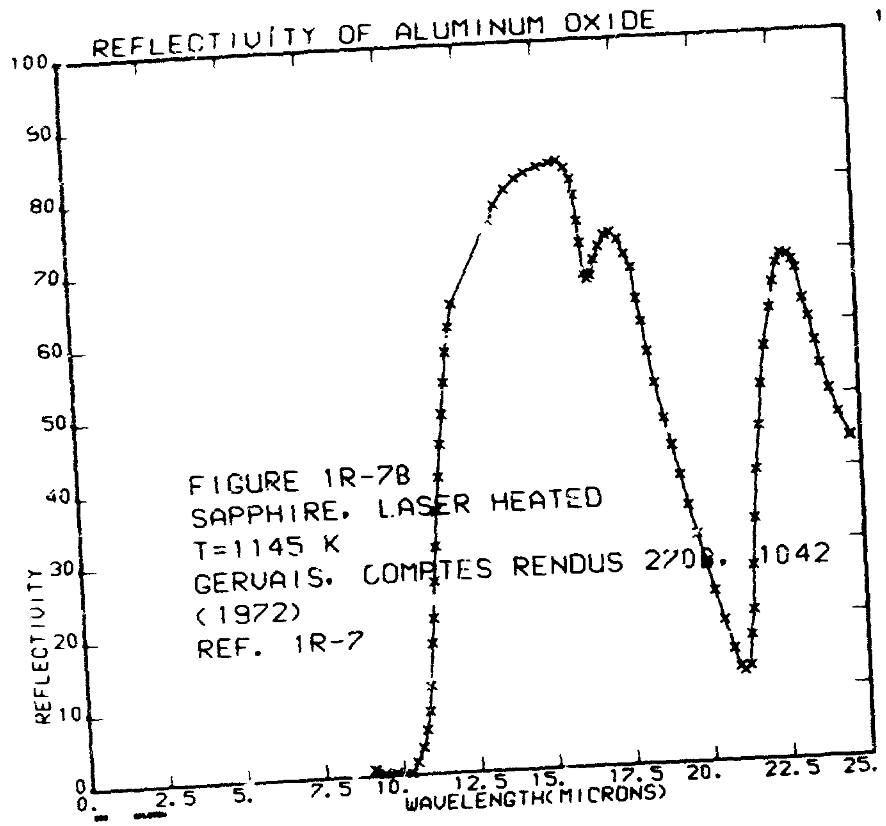

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7A
SAPPHIRE, LASER HEATED
T=960 K
GERVAIS, COMPTES RENDUS 270B, 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)
0
10
20
30
40
50
60
70
80
90
100
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7A
SAPPHIRE, LASER HEATED
T=960 K
GERVAIS, COMPTES RENDUS 270B, 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)
0
10
20
30
40
50
60
70
80
90
100
0.
5.
10.
15.
20.
25.
30.
35.
40.
45.
50.

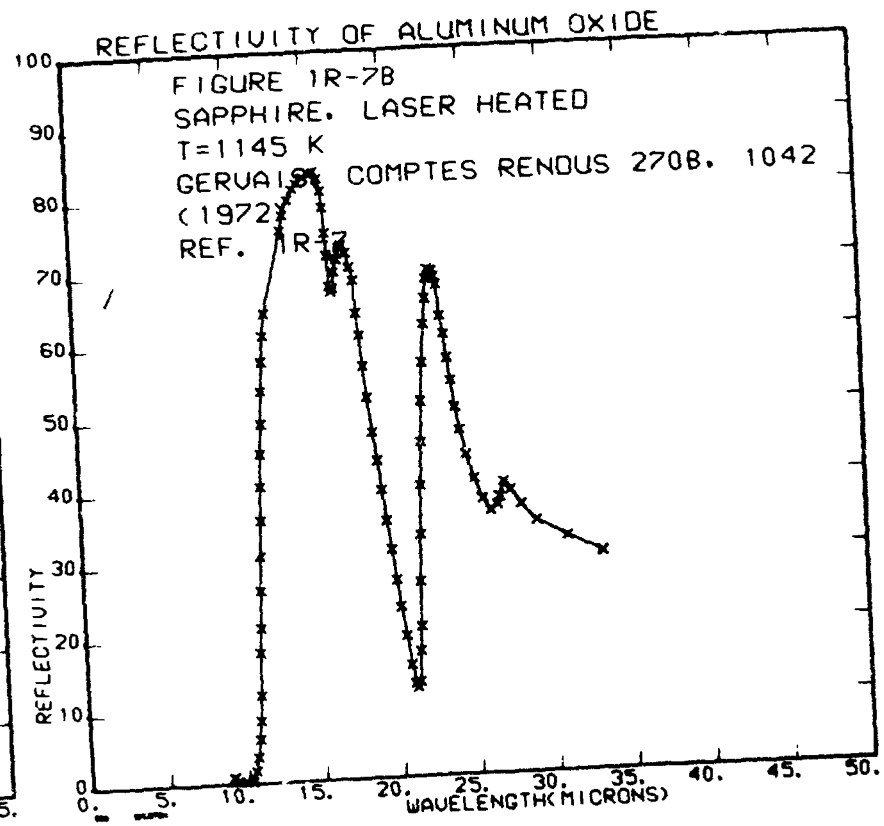
Gervais (Ref. 1P-7)

b. T = 1145°K ± 40°, laser heated.

λ	R	λ	R	λ	R
3.319E+01	2.982E+01	3.096E+01	3.214E+01	2.904E+01	3.448E+01
2.80[illegible]E+01	3.670E+01	2.743E+01	3.873E+[illegible]	2.704E+01	3.991E+01
2.672E+01	3.786E+01	2.659E+01	3.675E+01	2.610E+01	3.605E+01
2.562E+01	3.760E+01	2.512E+01	4.056E+01	2.467E+01	4.389E+01
2.434E+01	4.723E+01	2.408E+01	5.047E+01	2.385E+01	5.407E+01
2.368E+01	5.722E+01	2.351E+01	5.044E+01	2.333E+01	6.303E+01
2.316E+01	6.725E+01	2.302E+01	6.849E+01	2.290E+01	6.938E+01
2.269E+01	6.954E+01	2.252E+01	6.816E+01	2.242E+01	6.545E+01
2.226E+01	6.192E+01	2.206E+01	5.675E+01	2.191E+01	5.131E+01
2.180E+01	4.561E+01	2.166E+01	3.972E+01	2.156E+01	3.299E+01
2.147E+01	2.664E+01	2.142E+01	2.056E+01	2.132E+01	1.711E+01
2.123E+01	1.299E+01	2.107E+01	1.220E+01	2.091E+01	1.283E+01
2.074E+01	1.530E+01	2.045E+01	1.931E+01	2.019E+01	2.329E+01
1.996E+01	2.708E+01	1.971E+01	3.120E+01	1.946E+01	3.519E+01
1.922E+01	3.946E+01	1.901E+01	4.356E+01	1.878E+01	4.746E+01
1.854E+01	5.217E+01	1.834E+01	5.667E+01	1.819E+01	6.075E+01
1.804E+01	6.392E+01	1.790E+01	6.838E+01	1.770E+01	7.019E+01
1.751E+01	7.226E+01	1.728E+01	7.321E+01	1.712E+01	7.293E+01
1.692E+01	7.140E+01	1.673E+01	6.962E+01	1.661E+01	6.737E+01
1.651E+01	6.687E+01	1.640E+01	6.761E+01	1.631E+01	7.195E+01
1.626E+01	7.497E+01	1.616E+01	7.851E+01	1.608E+01	8.076E+01
1.591E+01	8.248E+01	1.569E+01	8.343E+01	1.543E+01	8.329E+01
1.534E+01	8.277E+01	1.463E+01	8.198E+01	1.433E+01	8.116E+01
1.397E+01	7.976E+01	1.363E+01	7.773E+01	1.341E+01	7.560E+01
1.215E+01	6.430E+01	1.201E+01	6.122E+01	1.189E+01	5.770E+01
1.178E+01	5.364E+01	1.168E+01	4.923E+01	1.159E+01	4.508E+01
1.149E+01	4.063E+01	1.14[illegible]	3.596E+01	1.131E+01	3.105E+01
1.125E+01	2.633E+01	[illegible]	2.126E+01	1.109E+01	1.784E+01
1.106E+01	1.200E+01	1.090E+01	8.565E+00	1.080E+01	6.006E+00
1.067E+01	3.639E+00	1.046E+01	1.741E+00	1.026E+01	2.611E-01
9.756E+00	3.134E-01	9.393E+00	3.482E-01	9.092E+00	9.749E-01
1.323E+01	1.472E+00	1.308E+01	1.451E+00	1.283E+01	1.437E+00
1.267E+01	1.428E+00	1.231E+01	1.386E+00	1.231E+01	1.339E+00
1.042E+01	1.260E+00	1.039E+01	1.075E+00	1.034E+01	8.328E-01
1.029E+01	7.432E-01	1.023E+01	6.124E-01	1.017E+01	5.065E-01
1.011E+01	4.384E-01	1.007E+01	3.423E-01	1.001E+01	2.608E-01
9.940E+00	2.040E-01	9.360E+00	1.877E-01	9.849E+00	1.831E-01
9.736E+00	1.960E-01	9.666E+00	2.221E-01	9.586E+00	2.712E-01
[illegible].542E+00	3.047E-01	9.438E+00	3.767E-01	9.366E+00	4.575E-01
9.246E+00	6.028E-01	9.190E+00	7.029E-01	9.144E+00	7.766E-01
9.117E+00	8.453E-01				



REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7B
SAPPHIRE. LASER HEATED
T=1145 K
GERVAIS. COMPTES RENDUS 270B. 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)

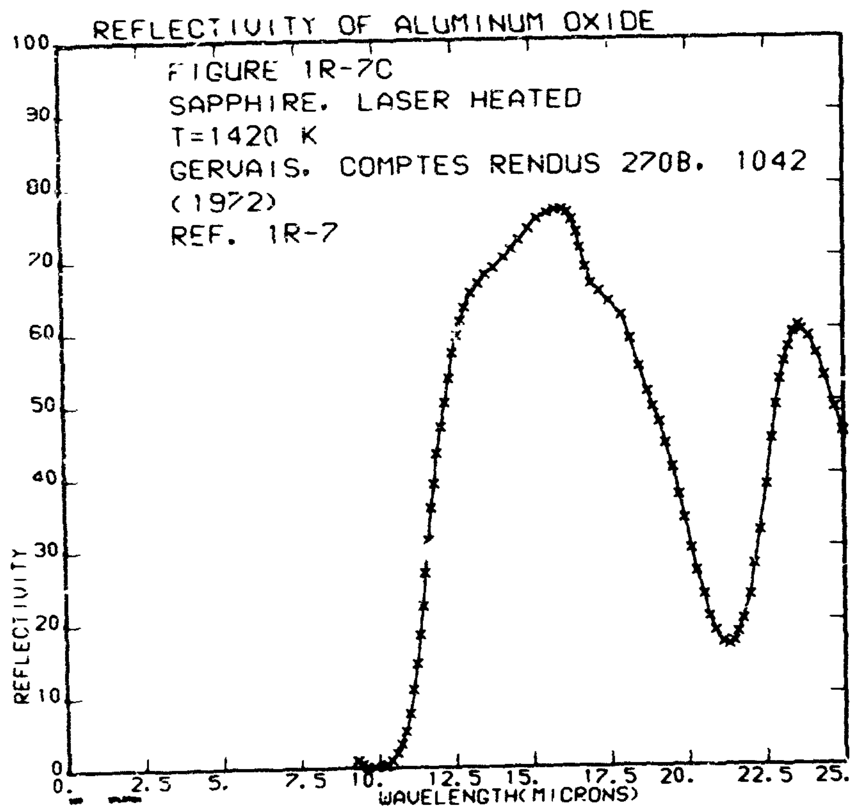


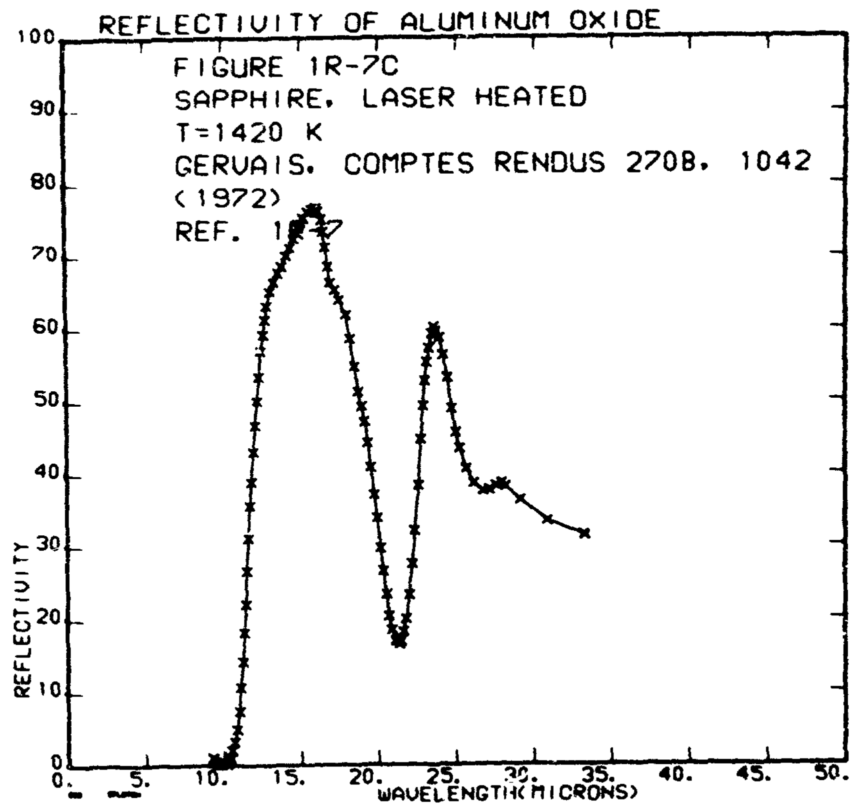
REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7B
SAPPHIRE. LASER HEATED
T=1145 K
GERVAIS. COMPTES RENDUS 270B. 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)

Gervais (Ref. 1R-7)

c. $T = 1420^{o}K \pm 30^{o}$, laser heated.

λ	R	λ	R	λ	R
33.2[illegible]	3.139E+01	30.895	3.347E+01	29.120	3.631E+01
2[illegible].178	3.824E+01	27.942	3.872E+01	27.581	3.831E+01
2[illegible].144	3.773E+01	26.744	3.760E+01	26.104	3.877E+01
2[illegible].534	4.075E+01	25.236	4.354E+01	24.992	4.572E+01
24.727	4.900E+01	24.411	5.333E+01	24.155	5.643E+01
23.904	5.680E+01	23.588	5.372E+01	23.582	6.033E+01
23.342	5.946E+01	23.252	5.742E+01	23.119	5.546E+01
22.945	5.291E+01	22.85[illegible]	4.943E+01	22.713	4.487E+01
22.546	3.639E+01	22.313	3.210E+01	22.145	2.758E+01
21.990	2.335E+01	21.769	2.004E+01	21.622	1.827E+01
21.458	1.695E+01	21.302	1.555E+01	21.157	1.695E+01
20.391	1.573E+01	20.68[illegible]	2.042E+01	20.507	2.345E+01
20.[illegible]95	2.651E+01	20.12[illegible]	2.970E+01	19.906	3.391E+01
19.728	3.718E+01	19.529	4.095E+01	19.320	4.435E+01
19.120	4.721E+01	18.914	4.934E+01	18.725	5.147E+01
18.[illegible]	5.467E+01	18.179	5.373E+01	17.899	6.195E+01
17.[illegible]19	6.420E+01	17.199	6.540E+01	16.929	6.644E+01
16.762	6.966E+01	16.595	7.131E+01	16.476	7.353E+01
16.3[illegible]	7.515E+01	16.18[illegible]	7.525E+01	16.030	7.667E+01
15.793	7.622E+01	15.53[illegible]	7.614E+01	15.214	7.532E+01
14.943	7.465E+01	14.641	7.254E+01	14.380	7.128E+01
14.144	7.017E+01	13.815	6.964E+01	13.546	6.772E+01
13.3[illegible]2	6.649E+01	13.0[illegible]	6.521E+01	12.865	6.322E+01
12.[illegible]	6.137E+01	12.500	5.935E+01	12.472	5.702E+01
12.[illegible]	5.341E+01	12.198	5.010E+01	12.070	4.671E+01
11.9[illegible]6	4.317E+01	11.827	3.895E+01	11.737	3.565E+01
11.[illegible]38	3.117E+01	11.542	2.658E+01	11.453	2.216E+01
11.3[illegible]4	1.826E+01	11.264	1.419E+01	11.145	1.070E+01
11.014	7.490E+00	10.873	4.972E+00	10.742	3.235E+00
10.[illegible]94	2.055E+00	10.404	1.084E+00	10.259	3.957E-01
10.[illegible]36	1.721E-01	9.870	1.721E-01	9.603	1.721E-01
9.[illegible]53	[illegible].334E-01	9.313	9.979E-01		

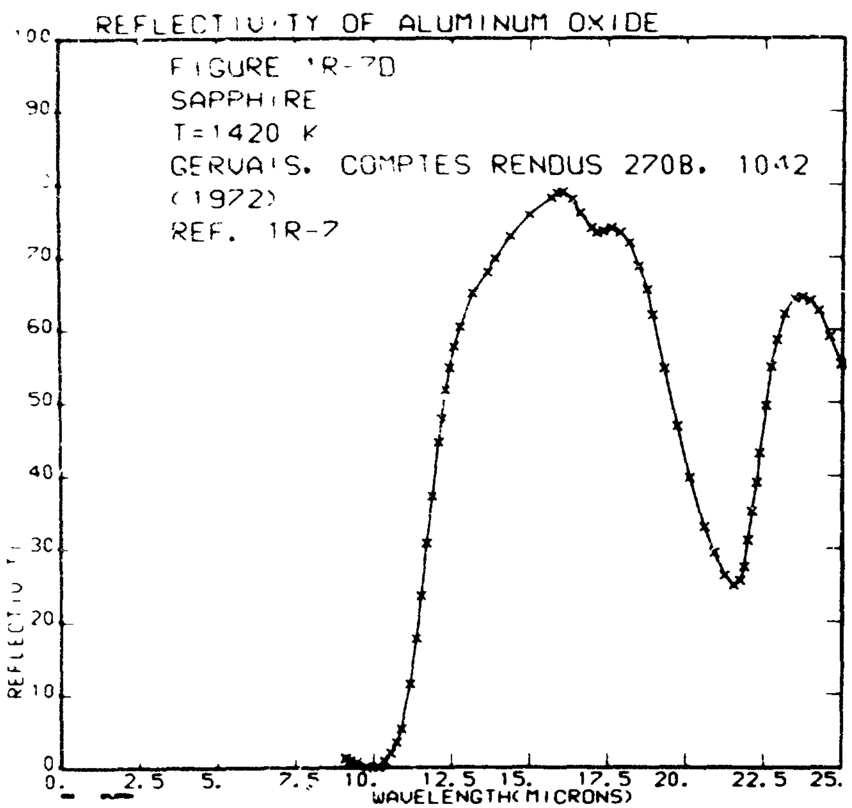

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7C
SAPPHIRE. LASER HEATED
T=1420 K
GERVAIS. COMPTES RENDUS 270B. 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

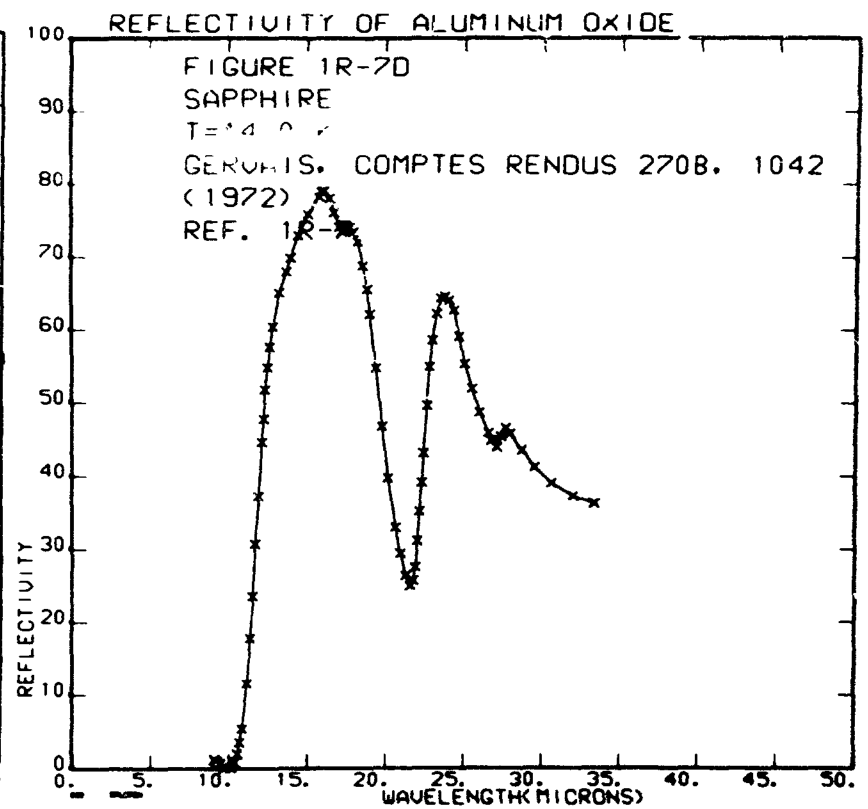

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7C
SAPPHIRE. LASER HEATED
T=1420 K
GERVAIS. COMPTES RENDUS 270B. 1042
(1972)
REF.
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

Gervais (Ref. 1R-7)

d. T = 1420°K $\pm$ 30°, furnace heated.

λ	R	λ	R	λ	R
33.333	3.624E+01	31.951	3.721E+01	30.377	3.907E+01
29.437	4.120E+01	28.572	4.350E+01	27.937	4.579E+01
[illegible]	4.657E+01	27.3[illegible]	4.544E+01	27.049	4.390E+01
26.715	4.442E+01	26.527	4.593E+01	25.943	4.879E+01
25.[illegible]	5.19[illegible]E+01	24.983	5.844E+01	24.515	5.916E+01
24.23[illegible]	6.2[illegible]E+01	23.974	6.415E+01	23.734	6.464E+01
23.[illegible]	6.441E+01	23.152	5.225E+01	22.935	5.859E+01
22.737	5.[illegible]E+01	22.530	4.961E+01	22.391	4.316E+01
22.256	3.910E+01	22.132	3.517E+01	22.016	3.115E+01
21.392	2.7[illegible]E+01	21.7[illegible]2	2.862E+01	21.568	2.497E+01
21.222	2.630E+01	20.345	2.949E+01	20.622	3.293E+01
20.1[illegible]1	3.973E+01	19.725	4.081E+01	19.310	5.485E+01
18.934	6.213E+01	18.754	5.559E+01	18.493	6.883E+01
18.131	[illegible].218E+01	17.[illegible]	[illegible].356E+01	17.615	7.415E+01
17.324	7.375E+01	17.147	7.349E+01	16.949	7.419E+01
16.517	7.611E+01	16.365	7.801E+01	16.024	7.933E+01
[illegible]	7.891E+01	15.596	7.425E+01	14.976	7.591E+01
14.352	7.299E+01	13.[illegible]	6.395E+01	13.625	6.804E+01
13.102	5.516E+01	12.[illegible]	6.041E+01	12.549	5.778E+01
12.413	5.434E+01	12.294	5.187E+01	12.153	4.782E+01
12.[illegible]	4.4[illegible]E+01	11.954	3.721E+01	11.693	3.070E+01
11.518	2.354E+01	11.394	1.772E+01	11.169	1.155E+01
10.733	5.299E+00	10.743	3.427E+00	10.569	1.944E+00
10.358	8.431E-01	10.153	3.441E-02	9.763	5.162E-02
9.424	6.356E-01	9.254	9.463E-01	9.104	1.256E+00

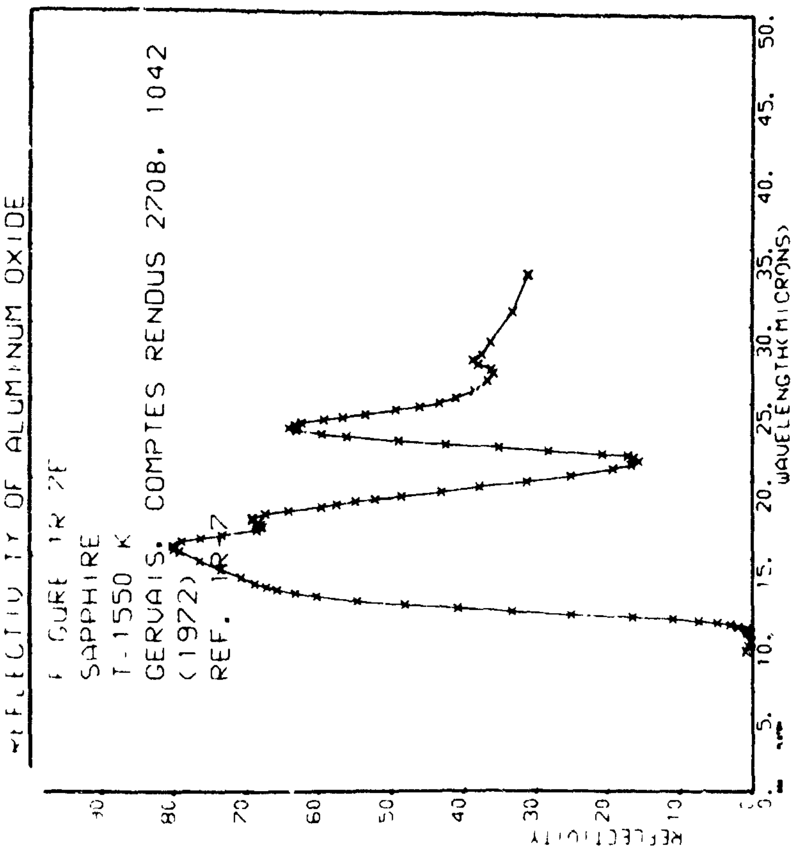

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7D
SAPPHIRE
T=1420 K
GERVAIS. COMPTES RENDUS 270B. 1042
(1972)
REF. 1R-7
WAVELENGTH(MICRONS)
REFLECTIVITY

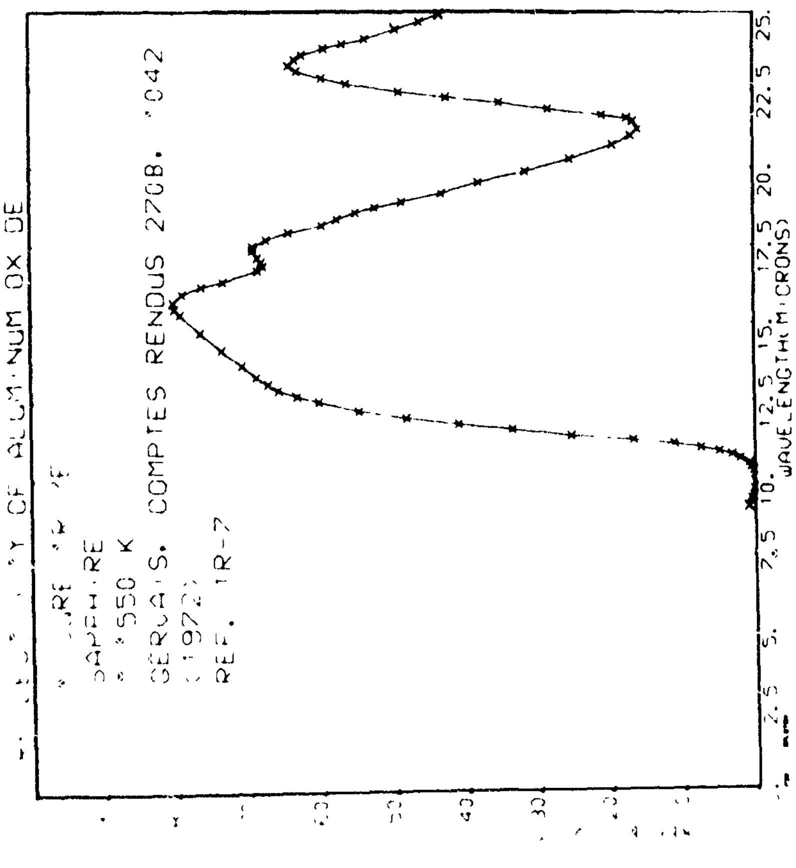

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7D
SAPPHIRE
GERVAIS. COMPTES RENDUS 270B. 1042
(1972)
WAVELENGTH(MICRONS)
REFLECTIVITY

Gervais (Ref. 1R-7)

e. $T = 1550^{o}K \pm 50^{o}$, laser he [illegible]d.

λ	R	λ	R	λ	R
3.329E+01	3.118E+01	3.066E+01	3.323E+01	2.889E+01	3.630E+01
2.808E+01	3.767E+01	2.773E+01	3.883E+01	2.741E+01	3.811E+01
2.71[illegible]E+01	3.529E+01	2.685E+01	3.593E+01	2.638E+01	3.680E+01
2.57[illegible]E+01	3.363E+01	2.529E+01	4.114E+01	2.492E+01	4.348E+01
2.[illegible]58E+01	4.614E+01	2.447E+01	4.947E+01	2.415E+01	5.365E+01
2.398E+01	5.570E+01	2.383E+01	5.934E+01	2.364E+01	6.241E+01
2.348E+01	6.346E+01	2.329E+01	6.421E+01	2.310E+01	6.311E+01
2.288E+01	5.968E+01	2.272E+01	5.624E+01	2.247E+01	4.906E+01
2.228E+01	4.257E+01	2.210E+01	3.511E+01	2.190E+01	2.824E+01
2.170E+01	2.379E+01	2.160E+01	1.720E+01	2.151E+01	1.647E+01
2.125E+01	1.576E+01	2.104E+01	1.671E+01	2.077E+01	1.922E+01
2.031E+01	2.512E+01	1.992E+01	3.132E+01	1.956E+01	3.794E+01
1.922E+01	4.310E+01	1.892E+01	4.863E+01	1.873E+01	5.229E+01
1.858E+01	5.505E+01	1.837E+01	5.762E+01	1.817E+01	5.973E+01
1.793E+01	6.439E+01	1.779E+01	6.742E+01	1.747E+01	6.930E+01
1.737E+01	6.930E+01	1.713E+01	6.861E+01	1.700E+01	6.811E+01
1.685E+01	6.785E+01	1.670E+01	6.863E+01	1.636E+01	7.347E+01
1.619E+01	7.643E+01	1.596E+01	7.902E+01	1.570E+01	8.028E+01
1.549E+01	8.014E+01	1.530E+01	7.935E+01	1.471E+01	7.669E+01
1.416E+01	7.366E+01	1.365E+01	7.081E+01	1.327E+01	6.892E+01
1.305E+01	6.721E+01	1.285E+01	6.582E+01	1.267E+01	6.339E+01
1.248E+01	6.034E+01	1.219E+01	5.470E+01	1.196E+01	4.812E+01
1.176E+01	4.080E+01	1.157E+01	3.330E+01	1.139E+01	2.514E+01
1.124E+01	1.668E+01	1.112E+01	1.106E+01	1.099E+01	7.399E+00
1.086E+01	4.875E+00	1.075E+01	3.116E+00	1.064E+01	2.054E+00
1.048E+01	1.297E+00	1.046E+01	1.119E+00	1.043E+01	9.839E-01
1.039E+01	8.521E-01	1.033E+01	7.189E-01	1.027E+01	5.987E-01
1.018E+01	4.396E-01	1.013E+01	4.425E-01	1.009E+01	4.091E-01
1.004E+01	3.231E-01	9.997E+00	3.005E-01	9.925E+00	2.960E-01
9.884E+00	2.377E-01	9.835E+00	3.0[illegible]E-01	9.720E+00	3.388E-01
9.553E+00	4.380E-01	9.410E+00	5.632E-01	9.297E+00	6.943E-01
9.196E+00	8.241E-01	9.120E+00	9.320E-01		

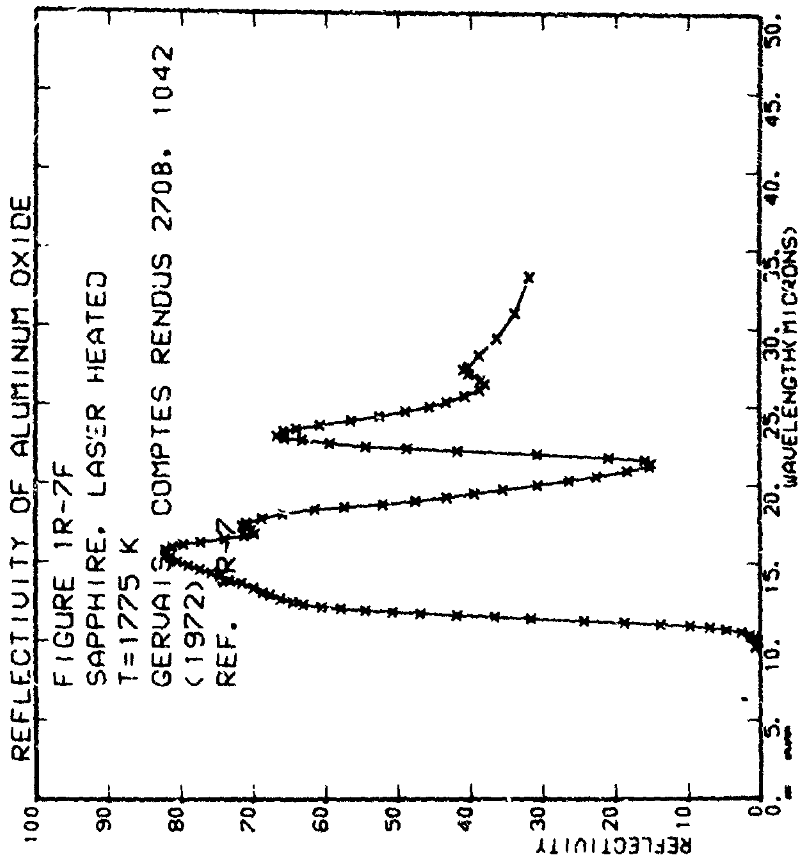

REFLECTIVITY OF ALUMINUM OXIDE
SAPPHIRE
T-1550 K
GERVAIS. COMPTES RENDUS 270B. 1042
(1972)
REF. IR-7
WAVELENGTH(MICRONS)
REFLECTIVITY

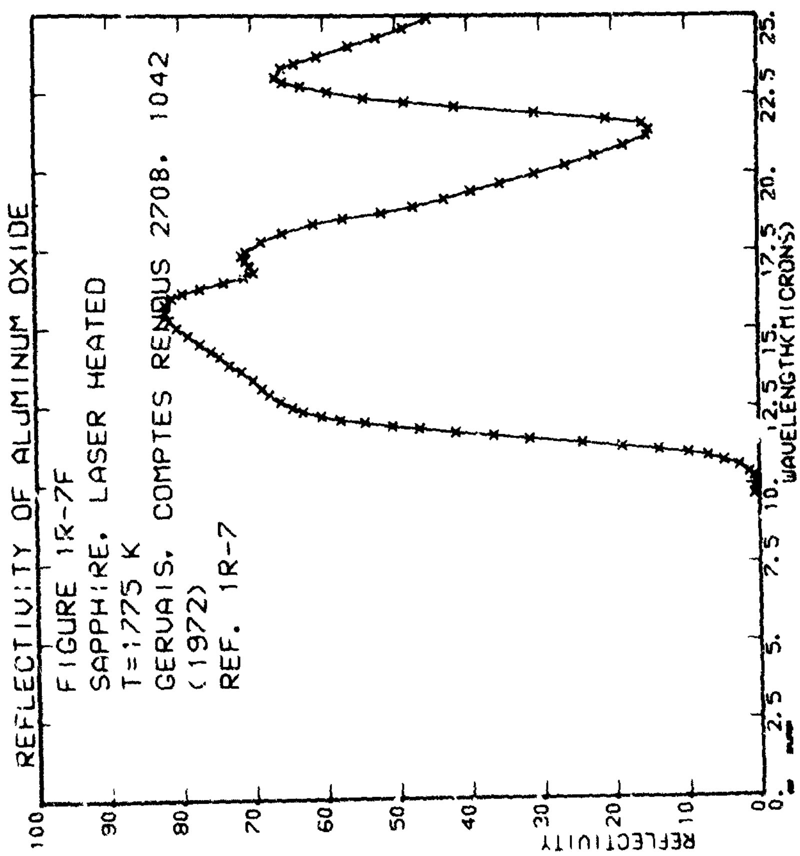

COMPTES RENDUS 270B.
(1972)
REF. IR-7
WAVELENGTH(MICRONS)

Gervais (Ref. 1R-7)

f. T = 1775°K $\pm$ 20°, laser heated.

λ	R	λ	R	λ	R
[illegible]	[illegible]	30.327	3.380E+01	29.301	3.625E+01
[illegible]	[illegible]	27.477	4.076E+01	27.310	4.094E+01
27.021	4.027E+01	26.636	3.351E+01	26.353	3.792E+01
26.026	3.872E+01	25.629	4.086E+01	25.236	4.322E+01
[illegible]	4.503E+01	24.520	4.893E+01	24.313	5.264E+01
[illegible]	[illegible]	23.714	[illegible]	23.493	6.407E+01
23.330	[illegible]	23.043	[illegible]	22.887	6.569E+01
[illegible]	5.321E+01	22.577	[illegible]	22.382	5.440E+01
[illegible]	4.972E+01	22.119	[illegible]	21.922	3.073E+01
[illegible]	2.086E+01	21.562	1.596E+01	21.372	1.492E+01
21.159	[illegible]	20.355	1.843E+01	20.535	2.249E+01
[illegible]	[illegible]	19.954	[illegible]	19.651	3.549E+01
[illegible]	3.953E+01	19.153	4.329E+01	18.909	4.767E+01
[illegible]	[illegible]	18.544	5.741E+01	18.363	6.155E+01
[illegible]	[illegible]	17.779	6.887E+01	17.470	7.096E+01
17.335	[illegible]	17.181	[illegible]	17.305	7.041E+01
[illegible]	[illegible]	16.657	7.122E+01	16.494	7.403E+01
16.237	[illegible]	16.141	[illegible]	15.976	8.122E+01
[illegible]	8.220E+01	[illegible]	8.215E+01	15.272	8.157E+01
[illegible]	8.052E+01	14.783	7.903E+01	14.521	7.742E+01
14.295	[illegible]	14.101	7.465E+01	13.838	7.329E+01
[illegible]	7.162E+01	13.343	[illegible]	13.083	6.880E+01
12.397	[illegible]	[illegible]	[illegible]	12.466	6.466E+01
12.333	[illegible]	[illegible]	6.058E+01	12.072	5.794E+01
[illegible]	[illegible]	11.856	5.071E+01	11.763	4.693E+01
[illegible]	4.182E+01	[illegible]	3.665E+01	11.456	3.159E+01
11.324	2.431E+01	11.220	1.384E+01	11.117	1.377E+01
11.015	[illegible]	10.903	6.913E+00	10.768	4.714E+00
10.513	2.727E+00	10.397	1.397E+00	10.250	7.071E-01
10.301	[illegible]	9.634	[illegible]		

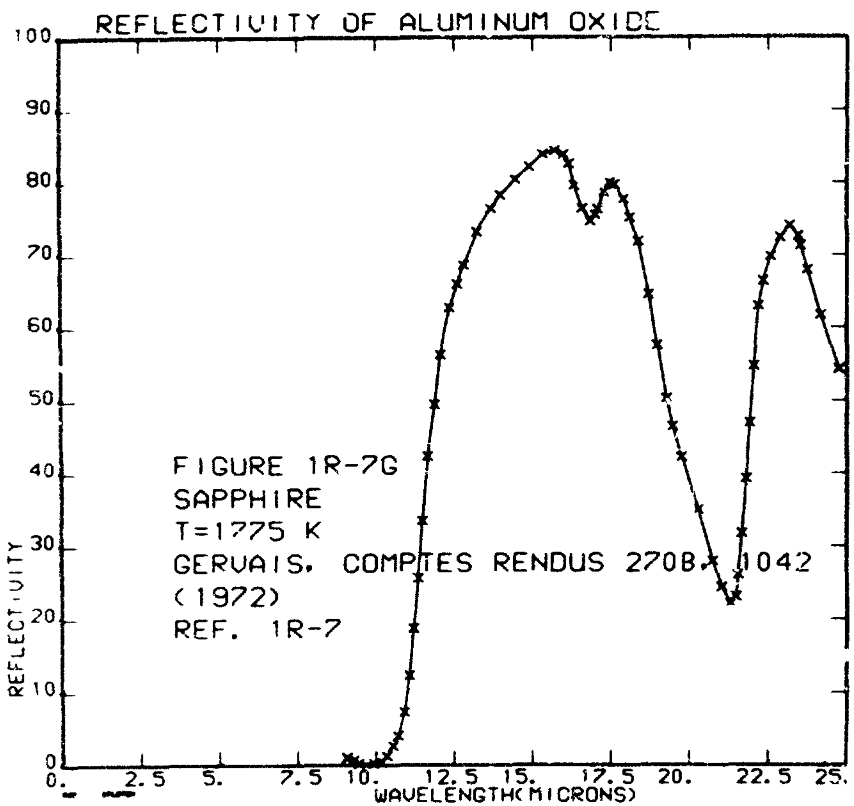

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7F
SAPPHIRE, LASER HEATED
T=1775 K
GERVAIS, COMPTES RENDUS 270B. 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

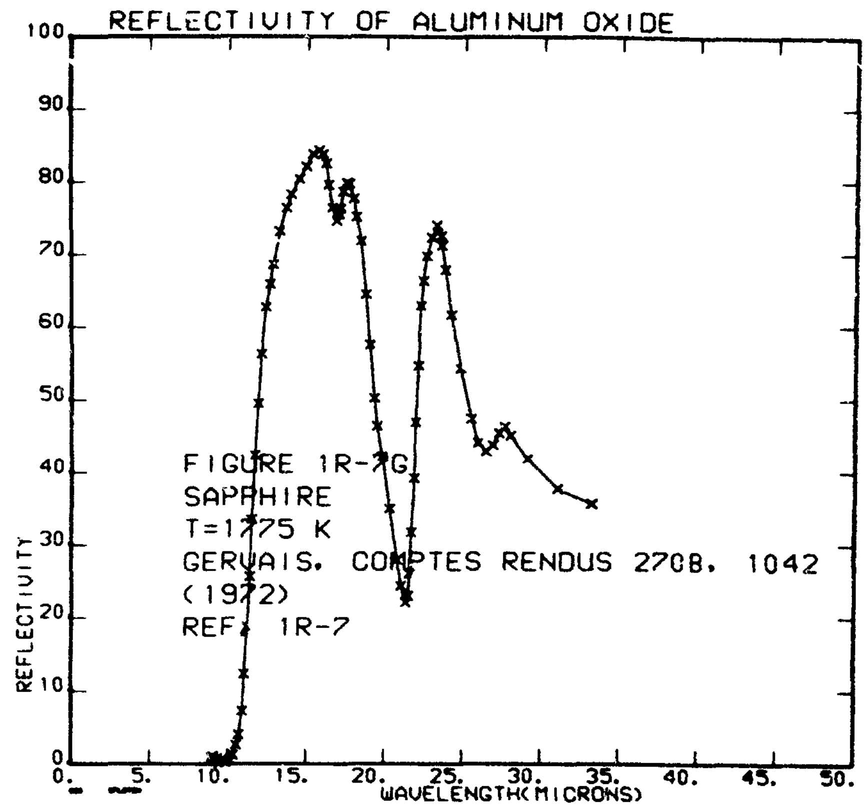

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7F
SAPPHIRE, LASER HEATED
T=1775 K
GERVAIS, COMPTES RENDUS 270B. 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

Gervais (Ref. 1R-7)

g   T = 1775°K ± 20°, furnace heated.

λ	R	λ	R	λ	R
33.236	3.575E+01	30.998	3.780E+01	29.089	4.196E+01
28.001	4.512E+01	27.605	4.531E+01	27.284	4.545E+01
26.580	4.382E+01	26.419	4.294E+01	25.934	4.419E+01
24.448	4.746E+01	24.743	5.439E+01	24.186	6.177E+01
23.764	5.794E+01	23.541	7.132E+01	23.470	7.259E+01
23.220	7.400E+01	22.890	7.244E+01	22.594	6.984E+01
22.349	6.640E+01	22.215	6.309E+01	22.050	5.471E+01
21.939	4.696E+01	21.822	3.927E+01	21.676	3.173E+01
21.562	2.600E+01	21.475	2.301E+01	21.320	2.210E+01
21.030	2.433E+01	20.771	2.790E+01	20.274	3.506E+01
19.758	4.220E+01	19.474	4.541E+01	19.231	5.038E+01
18.979	5.757E+01	18.712	6.466E+01	18.349	7.191E+01
18.120	7.515E+01	17.916	7.776E+01	17.598	7.970E+01
17.470	7.997E+01	17.275	7.879E+01	17.087	7.634E+01
17.319	7.553E+01	16.372	7.409E+01	16.587	7.646E+01
16.338	7.968E+01	16.152	8.254E+01	15.981	8.381E+01
15.719	8.434E+01	15.342	8.380E+01	14.903	8.218E+01
14.493	8.040E+01	13.933	7.838E+01	13.691	7.646E+01
13.241	7.322E+01	12.932	6.863E+01	12.601	6.600E+01
12.371	6.281E+01	12.070	5.539E+01	11.877	4.950E+01
11.671	4.241E+01	11.491	3.351E+01	11.352	2.562E+01
11.216	1.675E+01	11.077	1.234E+01	10.915	7.323E+00
10.730	4.074E+00	10.569	2.609E+00	10.366	1.229E+00
10.184	4.842E-01	9.942	2.189E-01	9.466	2.694E-01
9.313	7.744E-01	9.893	1.061E+00		

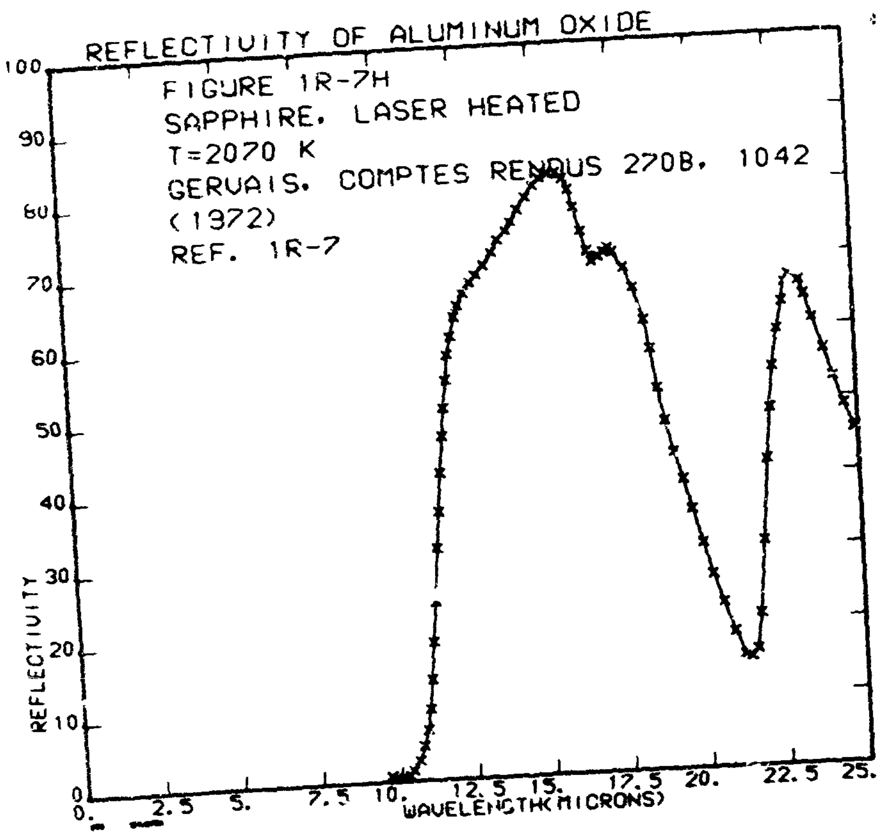

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7G
SAPPHIRE
T=1775 K
GERVAIS. COMPTES RENDUS 270B. 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

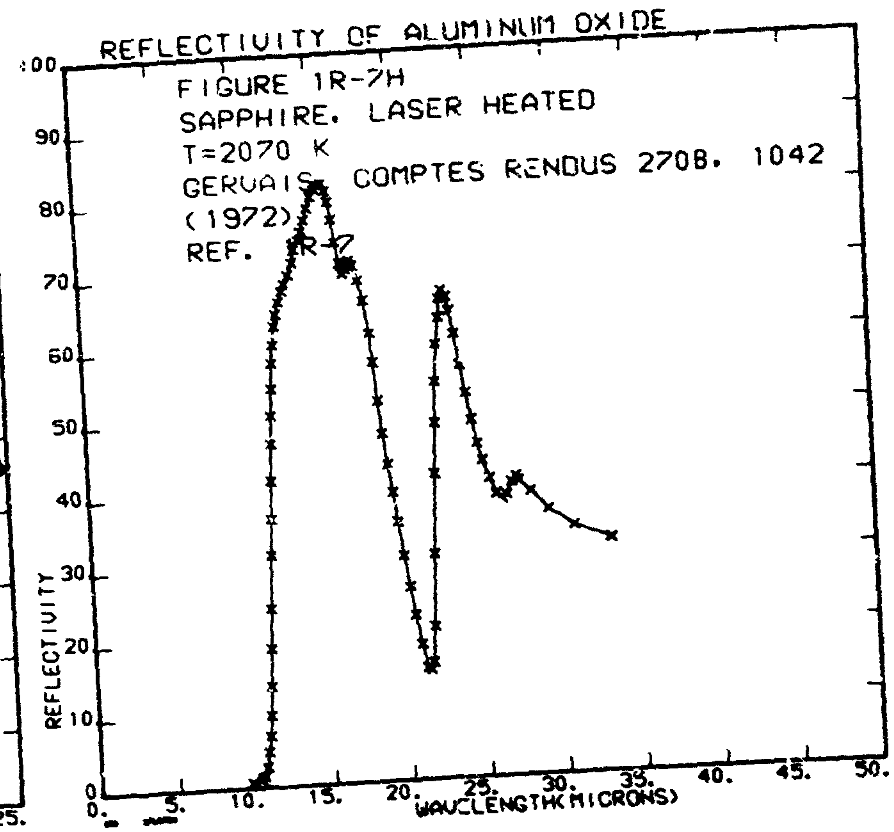

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7G
SAPPHIRE
T=1775 K
GERVAIS. COMPTES RENDUS 270B. 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

Gervais (Ref. 1R-7)

h. $T = 2070^{o}K \pm 20^{o}$, laser heated.

λ	R	λ	R	λ	R
3.322E+01	3.152E+01	3.065E+01	3.444E+01	2.965E+01	3.685E+01
2.808E+01	3.888E+01	2.769E+01	3.881E+01	2.693E+01	3.871E+01
2.616E+01	4.369E+01	2.548E+01	4.445E+01	2.472E+01	4.720E+01
2.442E+01	4.980E+01	2.417E+01	5.140E+01	2.397E+01	5.212E+01
2.363E+01	5.129E+01	2.339E+01	4.929E+01	2.312E+01	4.582E+01
2.295E+01	4.073E+01	2.275E+01	3.487E+01	2.244E+01	2.847E+01
2.204E+01	2.206E+01	2.174E+01	1.905E+01	2.146E+01	1.826E+01
2.106E+01	1.892E+01	2.089E+01	1.988E+01	2.056E+01	2.382E+01
2.024E+01	2.908E+01	1.996E+01	3.414E+01	1.966E+01	4.022E+01
1.933E+01	4.554E+01	1.916E+01	4.822E+01	1.879E+01	4.954E+01
1.815E+01	5.355E+01	1.770E+01	5.694E+01	1.728E+01	5.327E+01
1.709E+01	6.030E+01	1.684E+01	6.232E+01	1.665E+01	6.657E+01
1.652E+01	6.945E+01	1.637E+01	7.045E+01	1.614E+01	7.162E+01
1.586E+01	7.231E+01	1.557E+01	7.164E+01	1.503E+01	6.883E+01
1.454E+01	6.583E+01	1.410E+01	6.306E+01	1.366E+01	6.104E+01
1.322E+01	5.980E+01	1.285E+01	5.627E+01	1.251E+01	5.096E+01
1.228E+01	4.578E+01	1.210E+01	4.033E+01	1.184E+01	3.166E+01
1.166E+01	2.544E+01	1.150E+01	1.847E+01	1.133E+01	1.215E+01
1.115E+01	7.208E+00	1.093E+01	3.534E+00	1.070E+01	1.636E+00
1.057E+01	1.317E+00	1.055E+01	1.246E+00	1.054E+01	1.122E+00
1.050E+01	9.397E-01	1.045E+01	8.535E-01	1.041E+01	7.292E-01
1.036E+01	6.206E-01	1.027E+01	5.171E-01	1.015E+01	4.199E-01
1.035E+01	3.513E-01	9.946E+00	3.444E-01	9.831E+00	3.593E-01
9.649E+00	4.593E-01	9.515E+00	5.591E-01	9.399E+00	6.732E-01
9.296E+00	7.883E-01	9.267E+00	9.013E-01		


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7H
SAPPHIRE, LASER HEATED
T=2070 K
GERVAIS, COMPTES RENDUS 270B, 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-7H
SAPPHIRE, LASER HEATED
T=2070 K
GERVAIS, COMPTES RENDUS 270B, 1042
(1972)
REF. 1R-7
REFLECTIVITY
WAVELENGTH(MICRONS)

Harris (Re 1R-8)

The reflectance of 50, 100, and 200 volt aluminum oxide films from 14μ to 90μ was measured using a grating spectrometer. No estimates of error were given. Data were digitized from lines.

a. Thickness = 2800 Å (anodizing voltage of 200 volts).

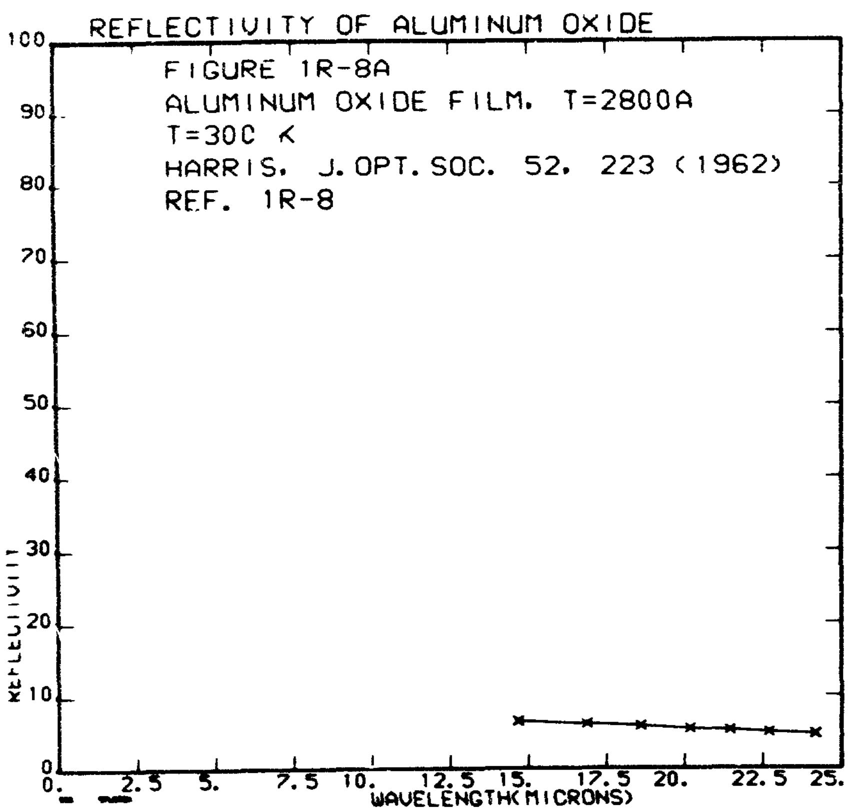
λ	R	λ	R	λ	R	λ	R
14.[illegible]	[illegible]E+00	15.[illegible]	5.1[illegible]E+00	18.501	5.[illegible]E+00	2[illegible].182	5.455E+00
21.[illegible]	[illegible].23[illegible]E+00	22.70[illegible]	4.[illegible]1E+00	24.132	4.789E+00	26.[illegible]57	4.677E+00
28.[illegible]23	4.[illegible]2[illegible]E+00	25.977	4.2[illegible]E+00	31.406	3.439E+00	32.333	3.390E+00
33.2[illegible]	2.9[illegible]E+00	34.3[illegible]	2.[illegible]E+00	35.882	2.642E+00	37.[illegible]79	2.4[illegible]E+00
39.[illegible]03	2.[illegible]E+00	41.297	1.9[illegible]E+00	43.70[illegible]	1.756E+00	46.211	1.490E+00
48.[illegible]2	1.24[illegible]E+00	51.[illegible]	1.[illegible]E+00	54.[illegible]2	7.[illegible]2[illegible]E-01	58.205	5.350E-01
51.511	4.53[illegible]E-01	65.497	3.23[illegible]E-01	59.63[illegible]	2.219E-01	73.533	1.54[illegible]E-01
77.1[illegible]	[illegible]E-02	80.[illegible]47	6.[illegible]12E-02	83.[illegible]3	4.305E-02	93.050	2.759E-02
83.[illegible]2	[illegible].[illegible]1[illegible]E-03						

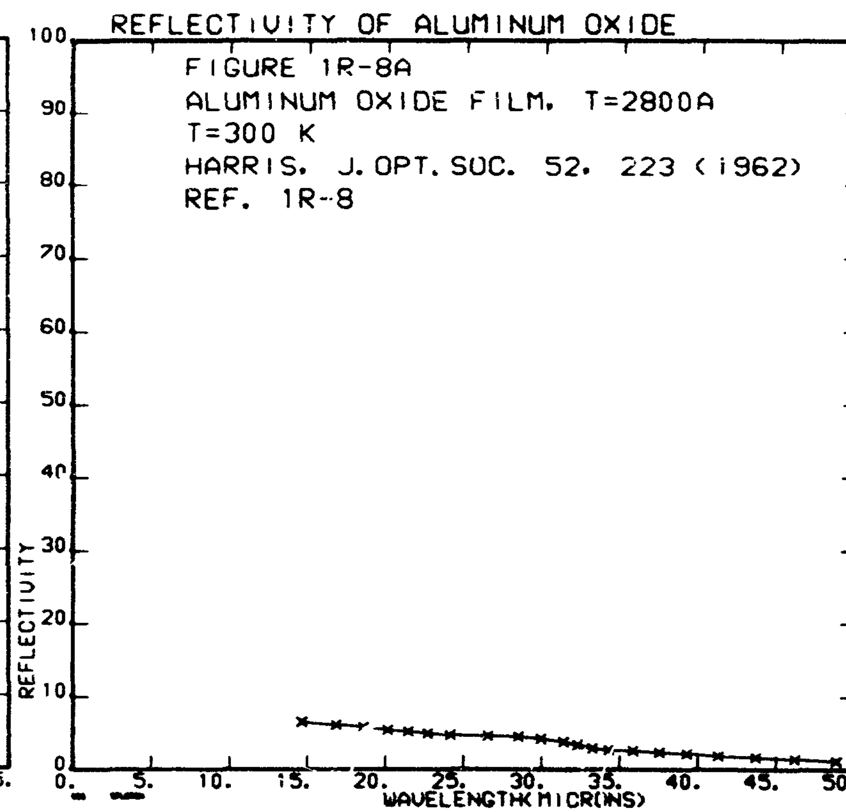
b. Thickness = 1370Å (100 volts)

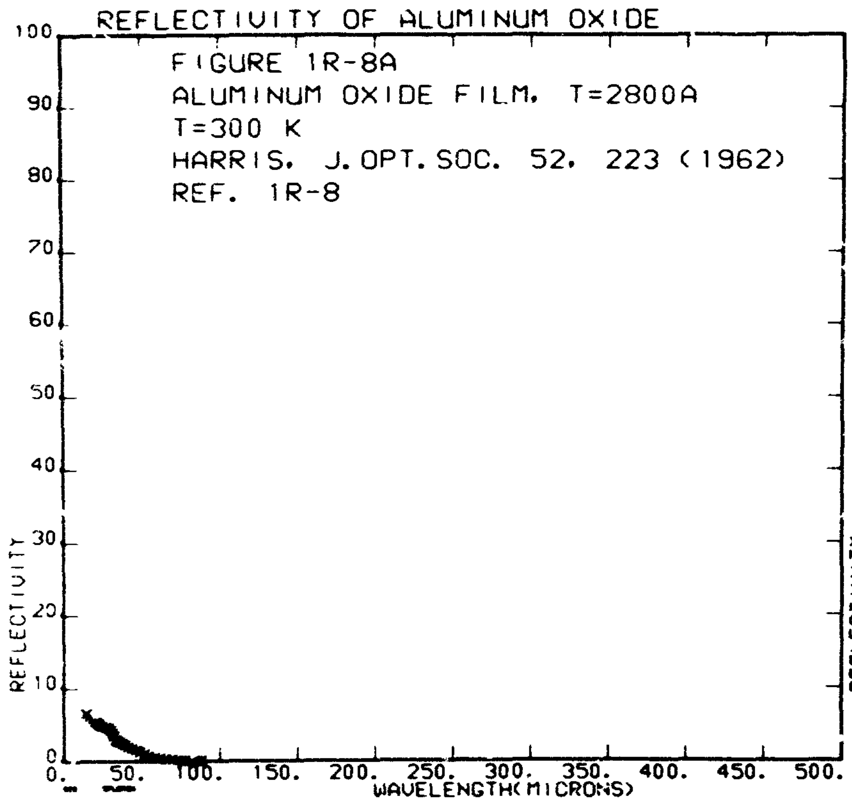
λ	R	λ	R	λ	R	λ	R
14.[illegible]1	2.[illegible]15E+00	15.[illegible]	2.3[illegible]E+00	17.392	2.278E+00	17.952	2.121E+00
18.[illegible]3	[illegible]E+00	16.[illegible]	1.[illegible]E+00	19.4[illegible]	1.765E+00	21.000	1.649E+00
22.[illegible]	[illegible].[illegible]6[illegible]E+00	24.36[illegible]	[illegible]E+00	2[illegible].[illegible]69	1.415E+00	2[illegible].364	1.341E+00
28.[illegible]	1.22[illegible]E+00	30.[illegible]	1.[illegible]E+00	[illegible]	8.[illegible]96E-01	32.701	6.96[illegible]E-01
33.[illegible]3	[illegible]E-01	34.90[illegible]	[illegible]E-01	[illegible].4[illegible]	4.338E-01	35.[illegible]	3.797E-01
39.[illegible]	3.[illegible]E-01	40.93[illegible]	3.[illegible]E-01	42.79[illegible]	4.172E-01	4[illegible].[illegible]69	3.940E-01
45.[illegible]	[illegible].3[illegible]E-01	[illegible].522	2.417E-01	51.034	1.[illegible]E-01	53.911	9.603E-02
55.[illegible]	3.97[illegible]E-02						

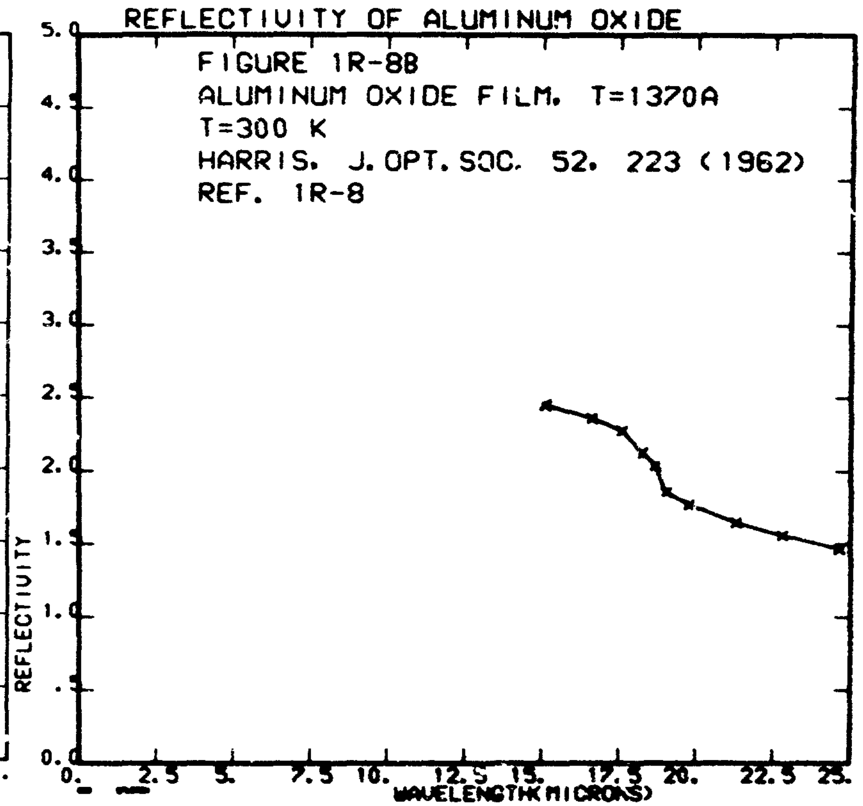
c. Thickness = 700 Å (50 volts)

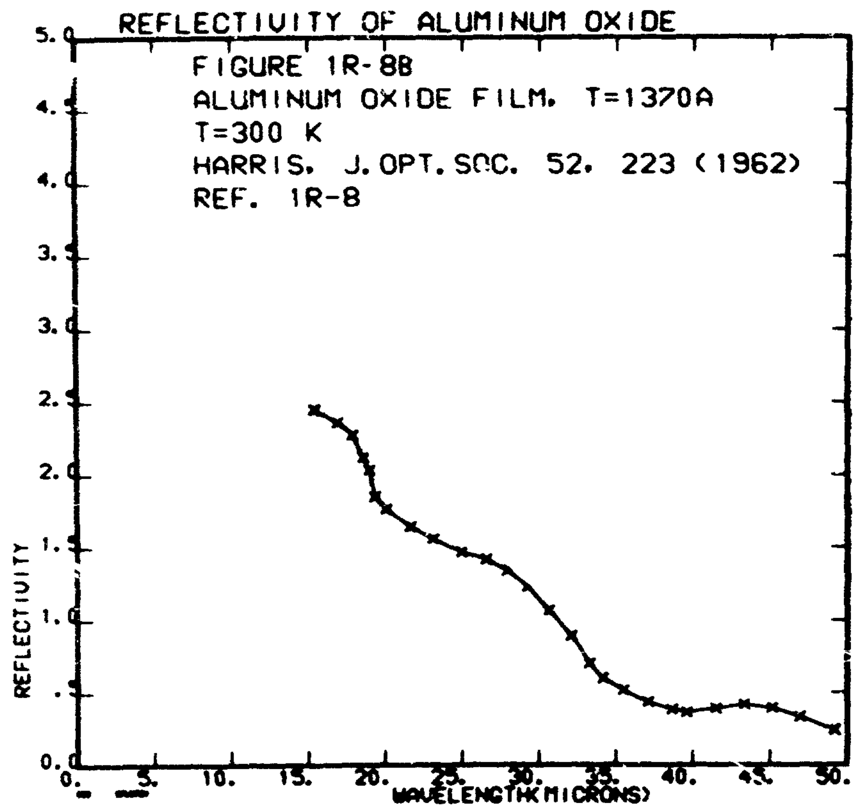
λ	R	λ	R	λ	R	λ	R
13.[illegible]	[illegible]E-01	1[illegible].[illegible]27	7.[illegible]E-01	1[illegible].[illegible]1[illegible]	7.[illegible]E-01	17.11[illegible]	8.135E-01
1[illegible]	[illegible]E-01	18.[illegible]	7.[illegible]E-01	19.[illegible]2	[illegible]E-01	20.3[illegible]	4.63[illegible]E-01
22.[illegible]2	3.[illegible]E-01	23.182	2.[illegible]E-01	23.[illegible]	1.[illegible]57E-01	24.534	7.7[illegible]6E-02
2[illegible]	[illegible]E-02						

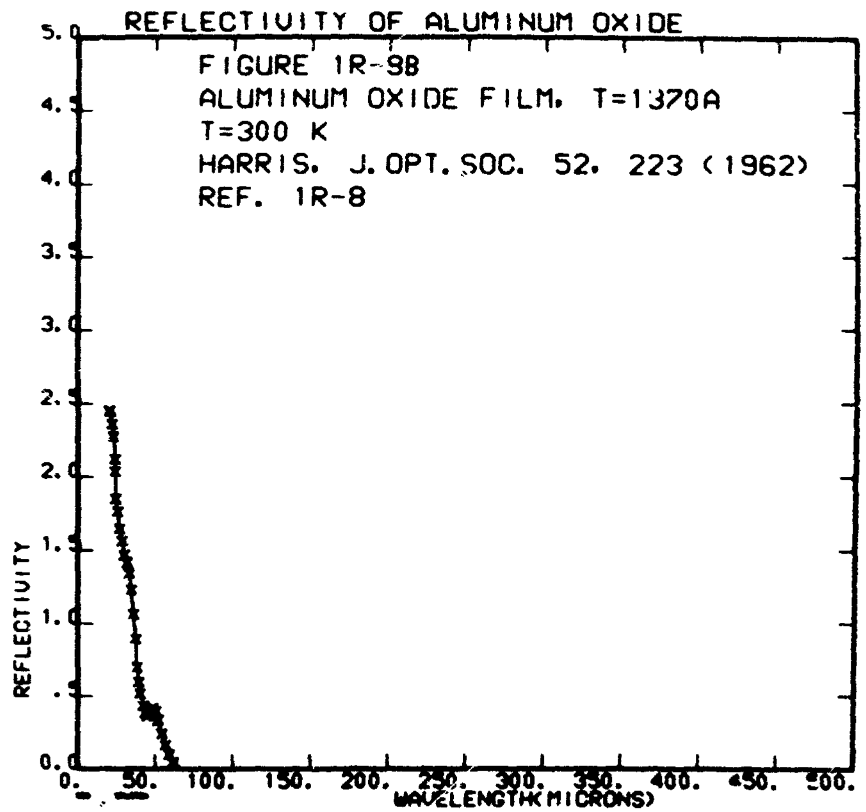

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-8A
ALUMINUM OXIDE FILM. T=2800A
T=30C K
HARRIS. J. OPT. SOC. 52. 223 (1962)
REF. 1R-8
REFLECTIVITY
WAVELENGTH(MICRONS)

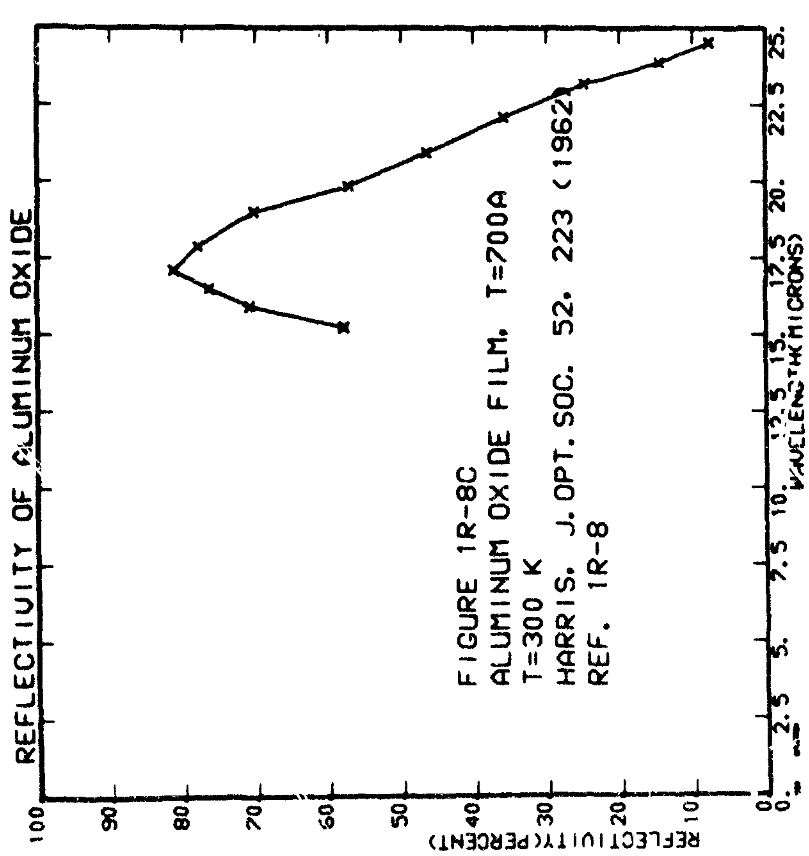

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-8A
ALUMINUM OXIDE FILM. T=2800A
T=300 K
HARRIS. J. OPT. SOC. 52. 223 (1962)
REF. 1R-8
REFLECTIVITY
WAVELENGTH(MICRONS)

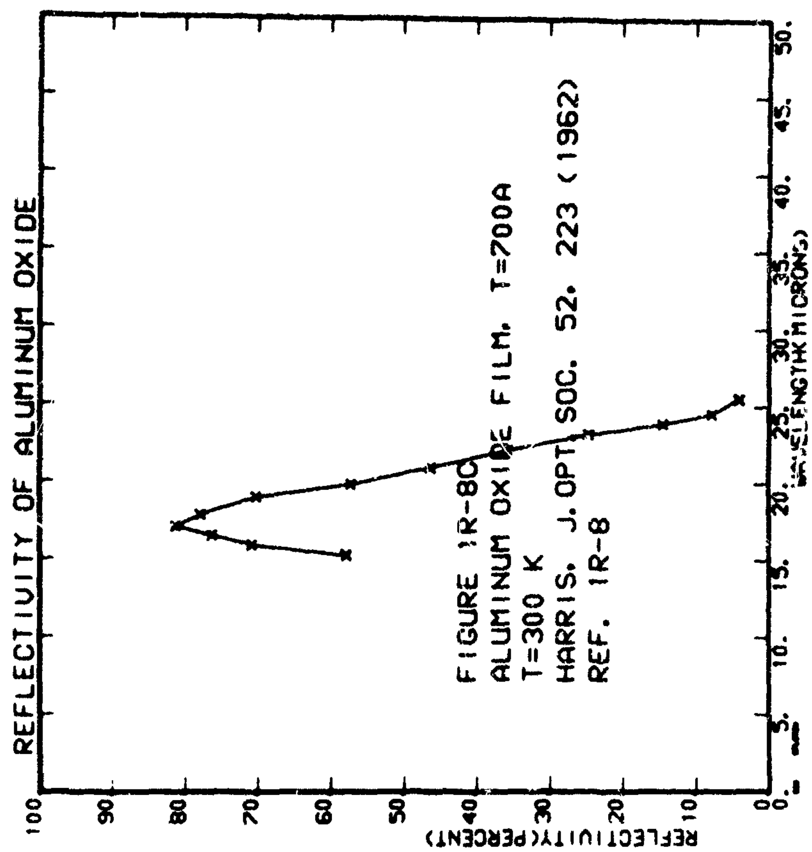

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-8A
ALUMINUM OXIDE FILM. T=2800A
T=300 K
HARRIS. J.OPT.SOC. 52. 223 (1962)
REF. 1R-8
REFLECTIVITY
WAVELENGTH(MICRONS)
0.
50.
100.
150.
200.
250.
300.
350.
400.
450.
500.
0
10
20
30
40
50
60
70
80
90
100


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-8B
ALUMINUM OXIDE FILM. T=1370A
T=300 K
HARRIS. J.OPT.SOC. 52. 223 (1962)
REF. 1R-8
REFLECTIVITY
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
0.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-8B
ALUMINUM OXIDE FILM, T=1370A
T=300 K
HARRIS, J. OPT. SOC. 52, 223 (1962)
REF. 1R-8
REFLECTIVITY
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-9B
ALUMINUM OXIDE FILM, T=1370A
T=300 K
HARRIS, J. OPT. SOC. 52, 223 (1962)
REF. 1R-8
REFLECTIVITY
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-8C
ALUMINUM OXIDE FILM, T=700A
T=300 K
HARRIS, J.OPT.SOC. 52, 223 (1962)
REF. 1R-8
REFLECTIVITY(PERCENT)
WAVELENGTH(MICRONS)
0. 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-8C
ALUMINUM OXIDE FILM, T=700A
T=300 K
HARRIS, J.OPT.SOC. 52, 223 (1962)
REF. 1R-8
REFLECTIVITY(PERCENT)
WAVELENGTH(MICRONS)
0. 10 20 30 40 50 60 70 80 90 100
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.

Levy (Ref. IR-10)

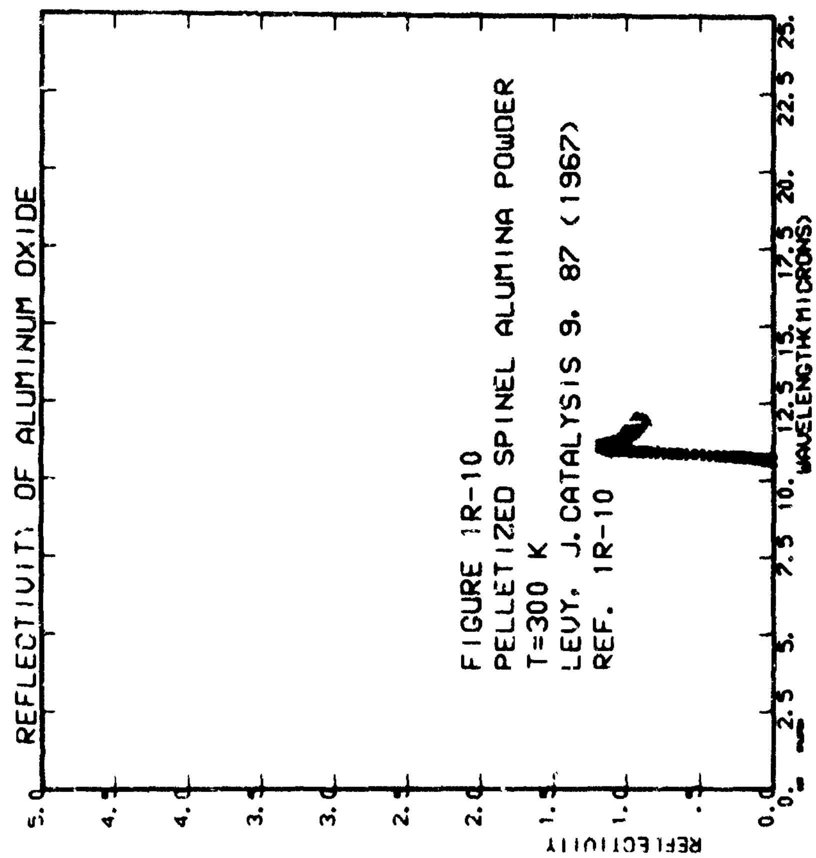
The relative reflectance of pelletized spinel alumina powder was measured on a Beckman IR-5 infrared spectrometer. The position and shape of the reflection maximum were found to be independent of pelletizing pressure or time and of the angle of incidence. No bandpass or error analysis data were given. Data points were digitized from a line.

These data are in generally good agreement with the representative curve given in Section I - 1.6. except for the peak shown at 11μ.

λ	R	λ	R	λ	R
10.342	1.377E+00	10.391	3.427E+00	10.370	3.688E+00
10.361	5.295E+00	10.396	5.638E+00	10.402	7.568E+00
10.415	9.615E+00	10.429	1.177E+01	10.435	1.362E+01
10.445	1.614E+01	10.447	1.765E+01	10.453	1.917E+01
10.432	2.125E+01	10.463	2.276E+01	10.468	2.410E+01
10.473	[illegible]	10.484	2.908E+01	10.490	3.094E+01
10.492	3.375E+01	10.499	3.659E+01	10.508	4.055E+01
10.515	4.009E+01	10.523	5.016E+01	10.539	5.559E+01
10.554	6.159E+01	10.560	6.527E+01	10.567	6.799E+01
10.572	7.234E+01	10.583	7.744E+01	10.599	8.095E+01
10.615	8.593E+01	10.630	8.931E+01	10.633	9.370E+01
10.644	9.555E+01	10.656	9.773E+01	10.664	9.995E+01
10.673	1.034E+02	10.681	1.053E+02	10.697	1.081E+02
10.715	1.037E+02	10.710	1.114E+02	10.720	1.126E+02
10.735	1.143E+02	10.753	1.148E+02	10.762	1.160E+02
10.775	1.164E+02	10.787	1.173E+02	10.800	1.176E+02
10.815	1.173E+02	10.826	1.156E+02	10.842	1.154E+02
10.854	1.139E+02	10.865	1.123E+02	10.893	1.118E+02
[illegible]	1.127E+02	10.907	1.103E+02	10.925	1.092E+02
10.942	1.081E+02	10.940	1.083E+02	10.955	1.078E+02
10.950	1.057E+02	10.980	1.053E+02	10.988	1.054E+02
10.999	1.045E+02	11.012	1.036E+02	11.033	1.025E+02
11.047	[illegible]	11.056	1.022E+02	11.063	1.013E+02
11.071	[illegible]	11.079	1.007E+02	11.097	1.004E+02
11.093	9.956E+01	11.110	9.893E+01	11.130	9.927E+01
11.125	9.885E+01	11.147	9.817E+01	11.158	9.836E+01
11.153	9.772E+01	11.166	9.709E+01	11.181	9.643E+01
11.195	9.604E+01	11.203	9.594E+01	11.217	9.637E+01
11.221	9.611E+01	11.230	9.541E+01	11.241	9.494E+01
11.253	9.482E+01	11.274	9.459E+01	11.282	9.484E+01
11.259	9.514E+01	11.296	9.441E+01	11.309	9.372E+01

Levy (Ref. 1R-10) Continued

λ	R	λ	R	λ	R
11.324	9.345E+01	11.339	9.350E+01	11.347	9.370E+01
11.355	9.432E+01	11.372	9.378E+01	11.393	9.345E+01
11.393	9.324E+01	11.403	9.290E+01	11.411	9.321E+01
11.423	9.314E+01	11.429	9.270E+01	11.438	9.185E+01
11.445	9.215E+01	11.460	9.181E+01	11.473	9.140E+01
11.482	9.177E+01	11.495	9.121E+01	11.505	9.132E+01
11.511	9.105E+01	11.522	9.132E+01	11.536	9.101E+01
11.552	9.103E+01	11.573	9.111E+01	11.595	9.075E+01
11.5[illegible]	9.072E+01				

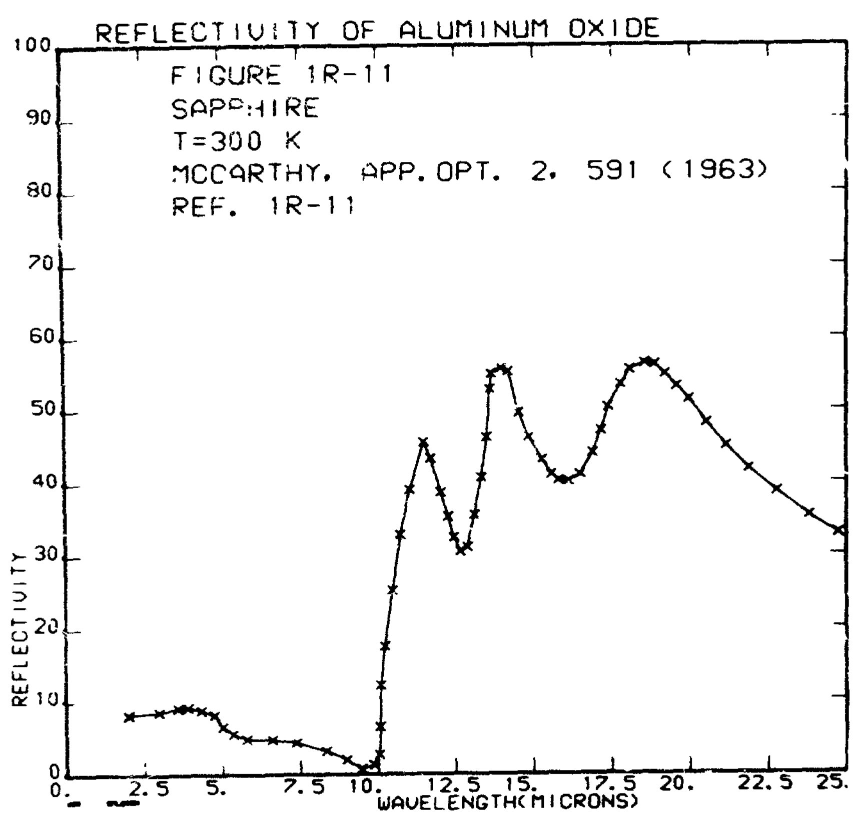

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE IR-10
PELLETIZED SPINEL ALUMINA POWDER
T=300 K
LEVY, J.CATALYSIS 9, 87 (1967)
REF. IR-10
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0.0 1.0 1.5 2.0 3.0 4.0 5.0

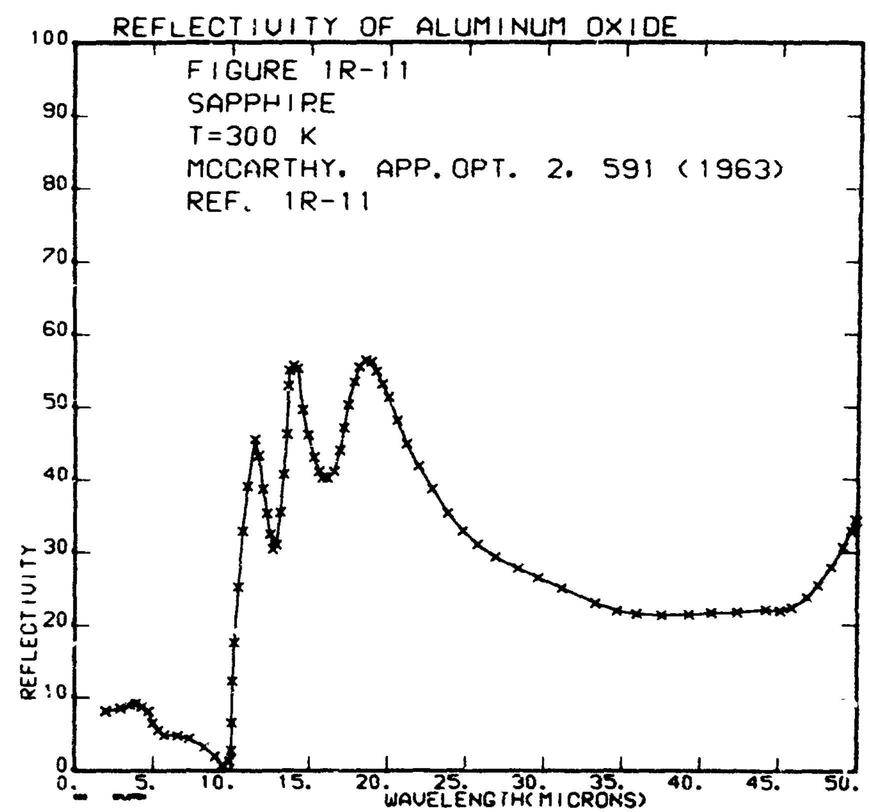
McCarthy (Ref. 1R-11)

A Beckman 1R-5A spectrometer in the 2μ to 6μ region and a Beckman 1R-7 with Cs I optics in the 12.5μ to 50μ region were used to measure the reflectance of 2 mm thick synthetic sapphire. No bandpass or error information was given. The sample temperature is unspecified and may be assumed to be approximately 300°K. These data were digitized from a line.

These data are in generally good agreement with the representative curve given in Section I-1.6.

λ	R	λ	P.	λ	R	λ	R
2.003	9.14[illegible]E+00	2.951	3.5[illegible]E+00	3.584	[illegible].050E+00	3.898	9.139E+00
4.332	3.[illegible]E+00	4.[illegible]	3.17[illegible]E+00	5.044	6.528E+00	5.370	5.519E+00
5.7[illegible]4	4.381E+00	6.504	4.719E+00	7.337	4.347E+00	8.364	3.116E+00
9.[illegible]	1.914E+00	9.494	7.85[illegible]E-01	9.895	1.231E+00	10.036	2.685E+00
10.[illegible]	5.[illegible]9E+00	10.108	1.22[illegible]E+01	10.275	1.753E+01	10.473	2.510E+01
10.738	5.281E+01	11.043	3.900E+01	11.485	4.55[illegible]E+01	11.701	4.329E+01
12.030	3.365E+01	12.263	3.73[illegible]E+01	12.460	3.243E+01	12.651	3.039E+01
12.[illegible]7	3.10[illegible]E+01	13.11[illegible]	3.[illegible]51E+01	13.327	4.070E+01	13.503	4.625E+01
13.616	[illegible].28[illegible]E+01	13.572	3.502E+01	13.973	5.575E+01	14.213	5.533E+01
14.[illegible]	4.362E+01	14.[illegible]72	4.513E+01	15.230	4.312E+01	15.595	4.112E+01
15.[illegible]9	4.928E+01	15.125	4.617E+01	16.[illegible]08	4.110E+01	16.902	4.404E+01
17.1[illegible]9	4.71[illegible]E+01	17.402	5.071E+01	17.839	5.346E+01	18.115	5.552E+01
18.5[illegible]7	5.543E+01	18.907	5.52[illegible]E+01	19.23[illegible]	5.495E+01	19.606	5.315E+01
20.[illegible]4	5.13[illegible]E+01	20.[illegible]49	4.312E+01	21.185	4.490E+01	21.900	4.188E+01
22.322	3.860E+01	23.[illegible]27	3.37[illegible]E+01	24.772	3.281E+01	25.731	3.105E+01
25.39[illegible]	2.931E+01	28.744	2.[illegible]E+01	29.632	2.642E+01	31.141	2.495E+01
33.2[illegible]2	2.297E+01	34.585	2.139E+01	35.914	2.150E+01	37.520	2.135E+01
39.27[illegible]	2.140E+01	40.704	2.160E+01	42.382	2.17[illegible]E+01	44.214	2.216E+01
45.127	2.194E+01	45.89[illegible]	2.24[illegible]E+01	46.912	2.377E+01	4[illegible].536	2.541E+01
48.[illegible]	2.797E+01	49.106	3.37[illegible]E+01	49.628	3.298E+01	49.941	3.441E+01


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-11
SAPPHIRE
T=300 K
MCCARTHY, APP.OPT. 2, 591 (1963)
REF. 1R-11
REFLECTIVITY
WAVELENGTH(MICRONS)

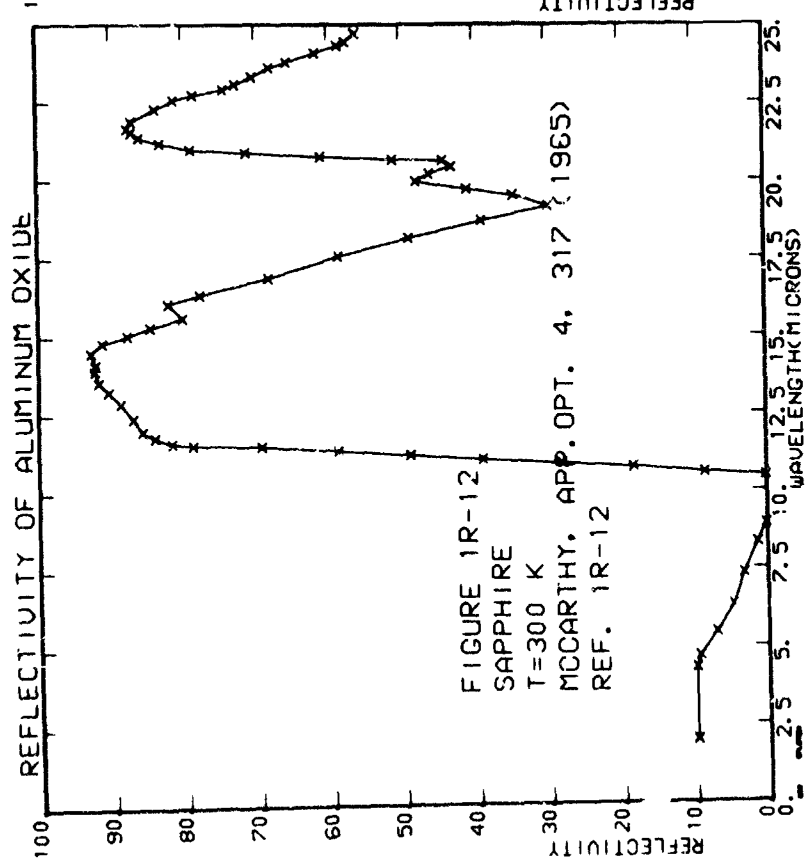

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-11
SAPPHIRE
T=300 K
MCCARTHY, APP.OPT. 2, 591 (1963)
REF. 1R-11
REFLECTIVITY
WAVELENGTH(MICRONS)

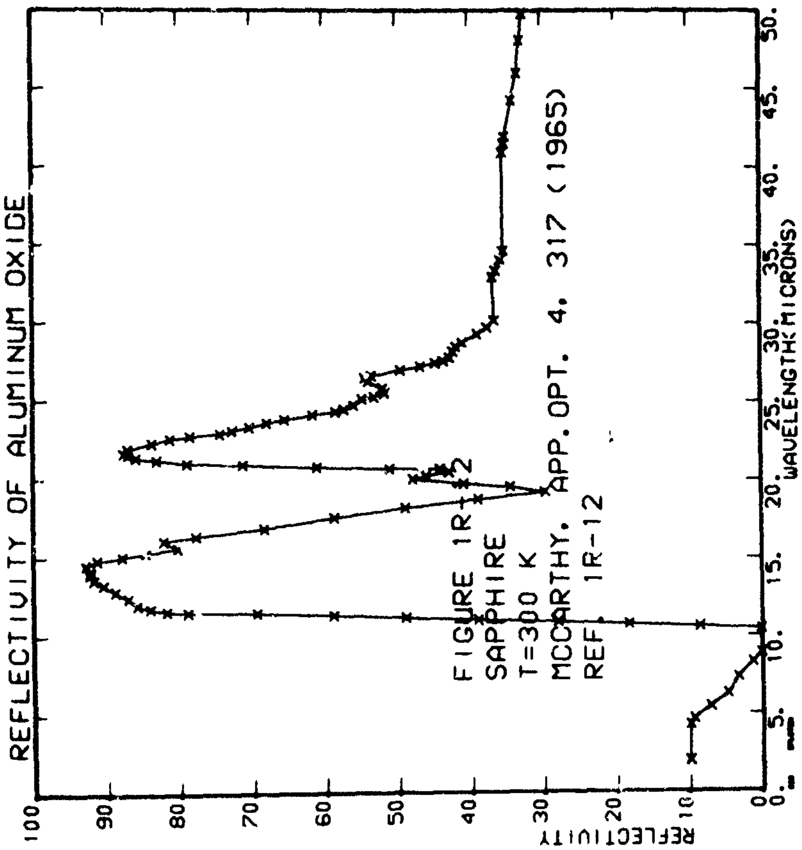
McCarthy (Ref. 1R-12)

Beckman 1R-5A, 1R-7, and 1R-9 spectrometers were used with a fixed angle specular reflection attachment to measure the reflectance of 3.0 mm thick sapphire from 2μ to 50μ. All sample surfaces were flat to ten fringes or better. No attempt was made to measure back surface reflectance contributions. No bandpass or error information was given. The sample temperature is unspecified and may be assumed to be approximately 300°K. These data were digitized from a line.

These data are in generally good agreement with the representative curve given in Section I-1.6.

λ	R	λ	R	λ	R	λ	R
2.004	9.390E+00	4.332	9.831E+00	4.713	9.405E+00	5.451	7.152E+00
5.377	4.757E+00	7.361	3.255E+00	9.333	1.315E+00	8.929	9.390E-02
10.474	9.390E-02	10.611	6.498E+00	10.789	1.838E+01	10.915	2.806E+01
11.045	3.905E+01	11.185	4.993E+01	11.336	5.894E+01	11.478	6.949E+01
11.5[illegible]3	7.896E+01	11.583	5.165E+01	11.789	8.416E+01	11.980	8.588E+01
12.421	8.735E+01	12.837	8.899E+01	13.263	9.059E+01	13.551	9.180E+01
13.939	9.232E+01	14.121	9.223E+01	14.499	9.281E+01	14.798	9.134E+01
15.350	8.788E+01	15.333	8.563E+01	15.614	8.319E+01	16.063	8.223E+01
16.349	7.782E+01	15.992	6.347E+01	17.590	5.875E+01	18.153	4.905E+01
18.715	3.897E+01	19.197	2.363E+01	19.530	3.456E+01	19.731	4.092E+01
19.396	4.799E+01	20.245	4.599E+01	20.470	4.291E+01	20.562	4.414E+01
20.555	5.109E+01	20.774	6.115E+01	20.911	7.135E+01	21.007	7.896E+01
21.204	8.212E+01	21.332	[illegible]	21.557	8.[illegible]01E+01	21.693	8.763E+01
21.910	8.590E+01	22.[illegible]	[illegible]	22.594	8.127E+01	22.761	7.850E+01
22.933	7.465E+01	23.[illegible]	7.273E+01	23.339	7.044E+01	23.635	6.80[illegible]E+01
23.910	6.553E+01	24.113	5.177E+01	24.330	6.949E+01	24.454	5.74[illegible]E+01
24.727	5.515E+01	25.095	5.495E+01	25.200	5.323E+01	25.504	5.1[illegible]E+01
25.705	5.207E+01	26.207	5.404E+01	26.453	5.454E+01	26.639	5.356E+01
26.973	4.352E+01	27.238	4.575E+01	27.430	4.462E+01	27.562	4.353E+01
27.[illegible]	4.27[illegible]E+01	28.149	4.233E+01	28.495	4.195E+01	28.701	4.101E+01
29.281	3.392E+01	29.732	3.751E+01	30.153	3.551E+01	32.992	3.672E+01
33.372	3.632E+01	34.398	3.574E+01	34.598	3.538E+01	40.936	3.543E+01
41.535	3.523E+01	41.933	3.504E+01	44.250	3.410E+01	46.001	3.333E+01
48.138	3.297E+01	49.815	3.253E+01				


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-12
SAPPHIRE
T=300 K
MCCARTHY. APP. OPT. 4. 317 (1965)
REF. 1R-12
REFLECTIVITY
WAVELENGTH(MICRONS)


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-12
SAPPHIRE
T=300 K
MCCARTHY. APP. OPT. 4. 317 (1965)
REF. 1R-12
REFLECTIVITY
WAVELENGTH(MICRONS)

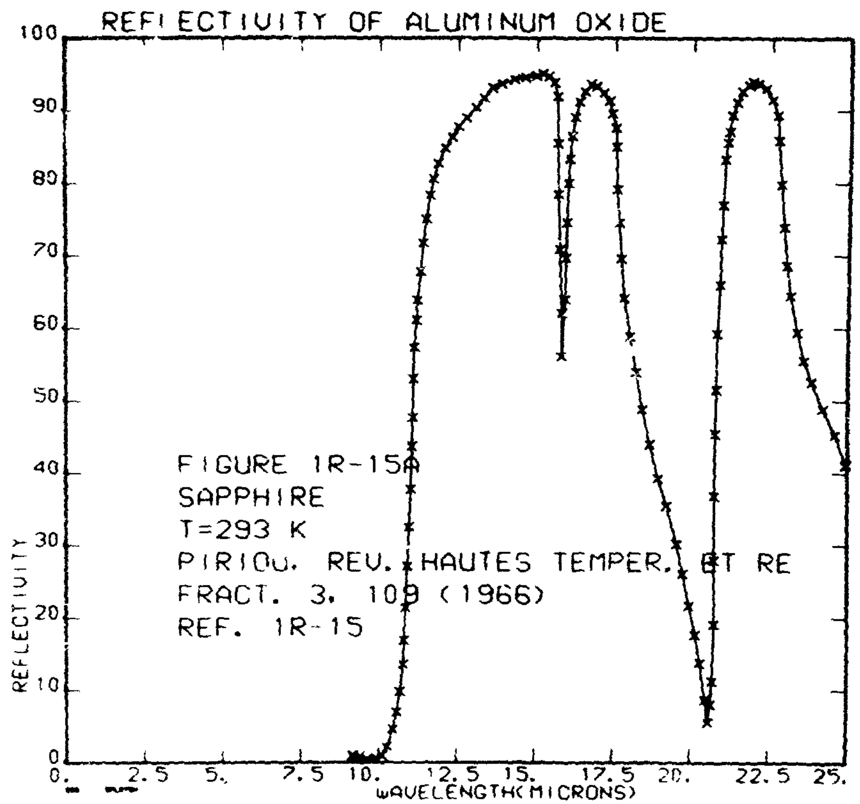
Piriou (Ref. 1R-15)

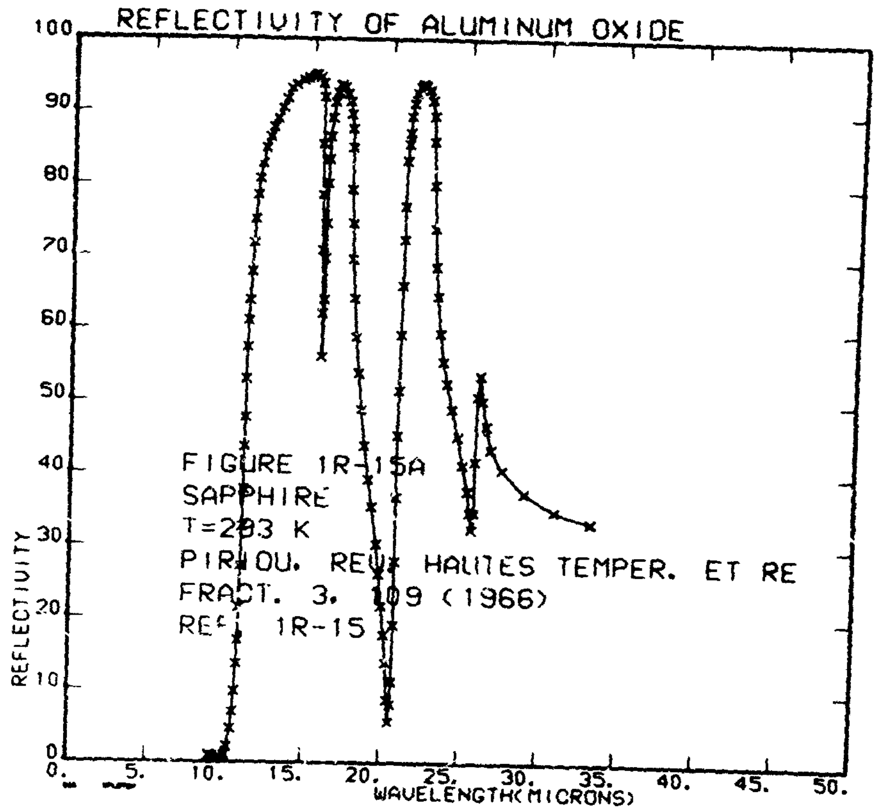
A grating spectrometer with unspecified bandpass was used to measure the reflectivity of sapphire (α - Al_2O_3) at T = 293°K and 1773°K. Temperatures were measured by pyrometer to a precision of better than 2 percent. No error analysis was given. Data were digitized from curves.

These data are in generally good agreement with the representative curve given in Section I-1.6.

a. T = 293°K

λ	R	λ	R	λ	R
33.246	3.338E+01	30.924	3.490E+01	28.954	3.748E+01
27.527	4.067E+01	26.788	4.351E+01	26.462	4.661E+01
26.161	5.023E+01	26.044	5.377E+01	25.858	5.088E+01
25.798	4.189E+01	25.757	3.475E+01	25.635	3.229E+01
25.480	3.475E+01	25.310	3.773E+01	24.953	4.125E+01
24.605	4.528E+01	24.201	4.389E+01	23.848	5.268E+01
23.610	5.558E+01	23.385	5.955E+01	23.171	6.460E+01
23.044	6.871E+01	22.926	7.403E+01	22.843	7.996E+01
22.737	8.598E+01	22.676	8.943E+01	22.498	9.163E+01
22.313	9.318E+01	22.057	9.377E+01	21.891	9.397E+01
21.753	9.357E+01	21.525	9.273E+01	21.374	9.128E+01
21.242	8.944E+01	21.150	8.710E+01	21.101	8.563E+01
21.036	8.332E+01	20.990	7.707E+01	20.946	7.241E+01
20.909	6.615E+01	20.846	5.932E+01	20.808	5.168E+01
20.777	4.529E+01	20.763	3.680E+01	20.763	2.792E+01
20.749	1.909E+01	20.709	1.120E+01	20.667	8.110E+00
20.577	5.633E+00	20.483	8.755E+00	20.299	1.384E+01
20.165	1.779E+01	19.950	2.172E+01	19.748	2.618E+01
19.558	3.024E+01	19.226	3.558E+01	18.970	3.925E+01
18.687	4.390E+01	18.442	4.886E+01	18.226	5.395E+01
18.038	5.895E+01	17.846	6.421E+01	17.745	6.969E+01
17.562	7.450E+01	17.591	7.925E+01	17.550	8.502E+01
17.528	8.764E+01	17.422	8.[illegible]61E+01	17.316	9.143E+01
17.139	9.257E+01	16.908	9.346E+01	16.737	9.371E+01
16.524	9.275E+01	16.370	9.134E+01	16.235	8.915E+01
16.136	8.654E+01	16.069	8.343E+01	16.035	8.011E+01
15.987	7.460E+01	15.969	6.979E+01	15.928	6.401E+01
15.843	5.610E+01	15.826	6.212E+01	15.766	7.091E+01
15.717	7.858E+01	15.689	8.556E+01	15.653	9.202E+01
15.566	9.394E+01	15.397	9.475E+01	15.180	9.518E+01
14.981	9.483E+01	14.630	9.462E+01	14.295	9.432E+01
13.892	9.374E+01	13.593	9.321E+01	13.298	9.184E+01
13.061	9.055E+01	12.762	8.900E+01	12.509	8.78[illegible]E+01
12.313	8.642E+01	12.079	8.493E+01	11.865	8.280E+01
11.717	8.076E+01	11.604	7.848E+01	11.490	7.512E+01
11.395	7.185E+01	11.309	6.799E+01	11.216	6.394E+01


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-15A
SAPPHIRE
T=293 K
PIRIOU. REV. HAUTES TEMPER. ET RE
FRACT. 3, 109 (1966)
REF. 1R-15
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

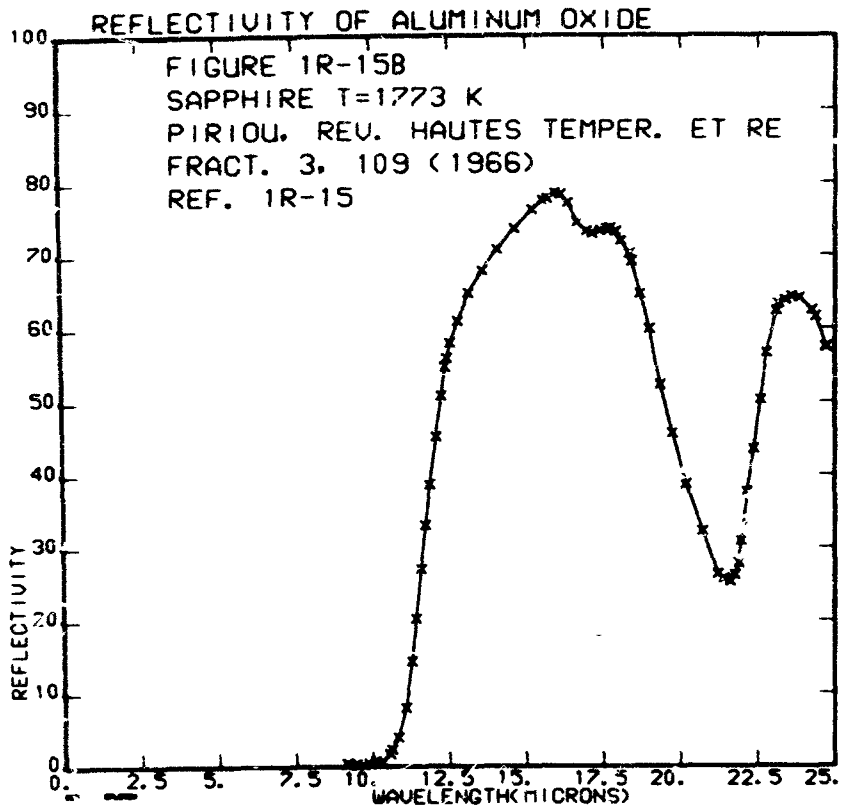

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-15A
SAPPHIRE
T=293 K
PIRIOU. REV. HAUTES TEMPER. ET RE
FRACT. 3, 109 (1966)
REF. 1R-15
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

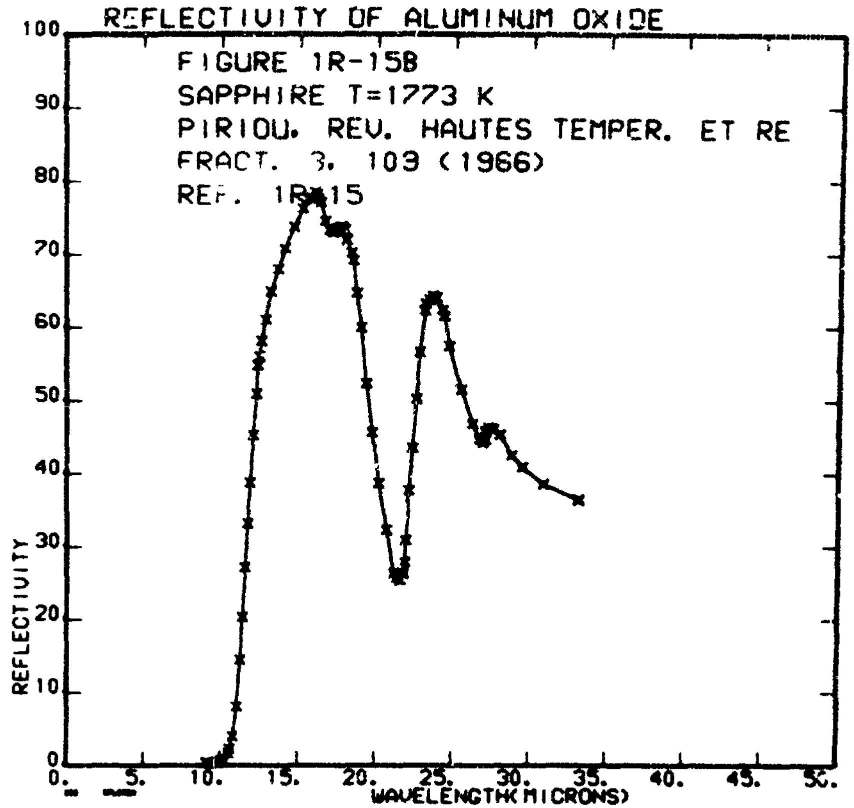
a. Continued

λ	R	λ	R	λ	R
11.175	6.117E+01	11.119	5.742E+01	11.084	5.306E+01
11.058	4.765E+01	11.032	4.379E+01	11.005	3.773E+01
10.967	3.257E+01	10.916	2.714E+01	10.871	2.144E+01
10.817	1.693E+01	10.778	1.363E+01	10.688	9.812E+00
10.591	7.086E+00	10.467	4.592E+00	10.294	2.114E+00
10.126	9.580E-01	9.983	3.964E-01	9.654	4.295E-01
9.378	8.259E-01	9.195	9.415E-01		

b. $T = 1773^{o}K$

λ	R	λ	R	λ	R
33.209	3.647E+01	30.905	3.864E+01	29.505	4.093E+01
28.844	4.257E+01	28.045	4.539E+01	27.607	4.623E+01
27.333	4.648E+01	27.128	4.597E+01	27.089	4.481E+01
26.921	4.438E+01	26.704	4.483E+01	26.283	4.698E+01
25.497	5.164E+01	24.729	5.750E+01	24.376	6.165E+01
24.251	6.259E+01	23.870	6.424E+01	23.607	6.442E+01
23.399	6.391E+01	23.174	6.343E+01	23.111	6.241E+01
22.819	5.677E+01	22.605	5.033E+01	22.385	4.352E+01
22.176	3.769E+01	21.987	3.092E+01	21.904	2.785E+01
21.797	2.626E+01	21.623	2.536E+01	21.431	2.577E+01
21.224	2.638E+01	20.723	3.229E+01	20.213	3.870E+01
19.756	4.572E+01	19.372	5.246E+01	19.001	6.003E+01
18.717	6.485E+01	18.447	6.928E+01	18.359	7.033E+01
18.090	7.218E+01	17.931	7.344E+01	17.764	7.382E+01
17.645	7.377E+01	17.429	7.359E+01	17.172	7.316E+01
16.982	7.342E+01	16.693	7.460E+01	16.387	7.722E+01
16.131	7.841E+01	15.958	7.868E+01	15.715	7.788E+01
15.559	7.762E+01	15.226	7.638E+01	14.656	7.384E+01
14.095	7.098E+01	13.622	6.807E+01	13.165	6.508E+01
12.821	6.117E+01	12.565	5.819E+01	12.468	5.611E+01
12.392	5.492E+01	12.249	5.099E+01	12.085	4.529E+01
11.884	3.885E+01	11.745	3.327E+01	11.586	2.719E+01
11.426	2.030E+01	11.273	1.444E+01	11.082	8.044E+00
10.841	4.047E+00	10.625	2.296E+00	10.550	1.767E+00
10.281	5.781E-01	10.076	7.433E-01	9.868	5.286E-01
9.469	4.130E-01	9.151	4.460E-01		

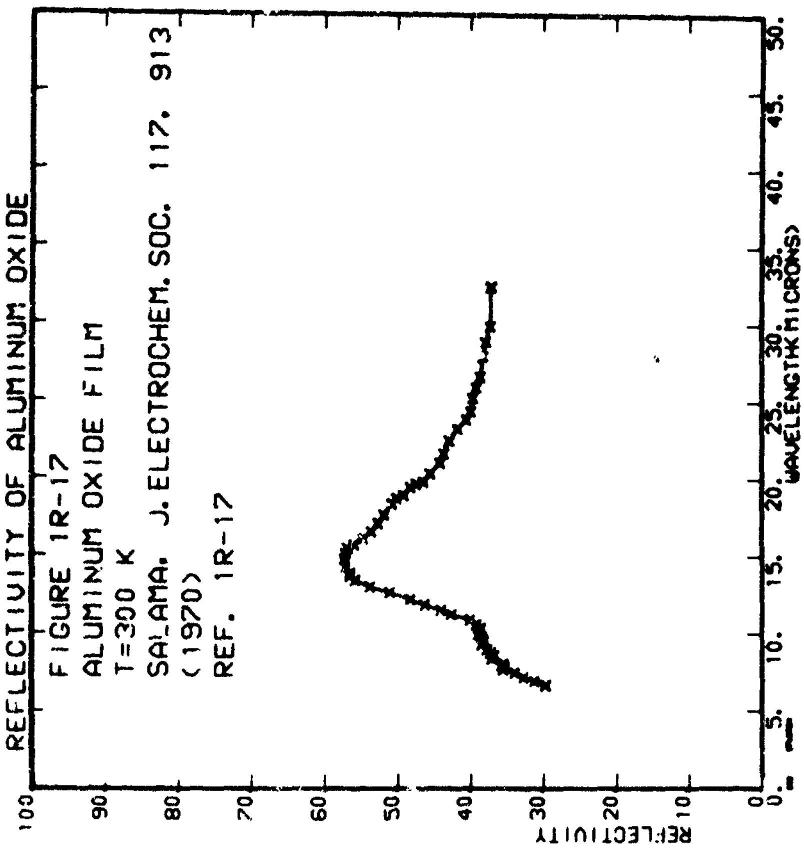

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-15B
SAPPHIRE T=1773 K
PIRIOU. REV. HAUTES TEMPER. ET RE
FRACT. 3. 109 (1966)
REF. 1R-15
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 10. 20. 30. 40. 50. 60. 70. 80. 90. 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

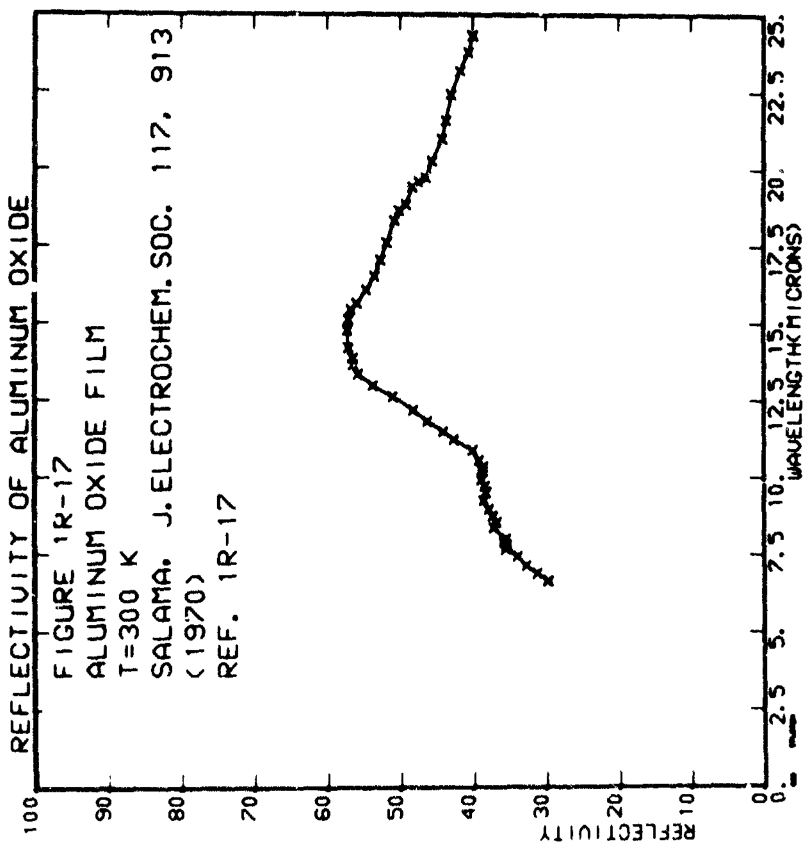

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-15B
SAPPHIRE T=1773 K
PIRIOU. REV. HAUTES TEMPER. ET RE
FRACT. 3. 109 (1966)
REF. 1R-15
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 10. 20. 30. 40. 50. 60. 70. 80. 90. 100
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.

Salama (Ref. 1R-17)

RF-sputtered aluminum oxide films on silicon, with densities ranging from 3.1 to 3.8 g/cm^3 and thickness $\leq$ 5000 Å, were studied. No experimental details on the measurement of the relative reflectance were given. These data were digitized from lines.

λ	R	λ	R	λ	R
6.557	2.973E+01	6.921	3.126E+01	7.163	3.275E+01
7.432	3.397E+01	7.688	3.557E+01	7.811	3.541E+01
7.913	3.575E+01	8.014	3.557E+01	8.392	3.712E+01
8.557	3.684E+01	8.746	3.737E+01	8.993	3.785E+01
9.259	3.850E+01	9.523	3.828E+01	9.727	3.847E+01
9.929	3.847E+01	10.246	3.970E+01	10.349	3.867E+01
10.572	3.927E+01	10.873	4.014E+01	11.234	4.274E+01
11.433	4.412E+01	11.839	4.630E+01	12.177	4.835E+01
12.332	5.115E+01	12.391	5.380E+01	13.359	5.590E+01
13.639	5.853E+01	13.366	5.650E+01	14.198	5.721E+01
14.775	5.734E+01	15.136	5.721E+01	15.455	5.698E+01
16.570	5.687E+01	16.677	5.476E+01	16.525	5.367E+01
17.555	5.273E+01	17.636	5.194E+01	18.323	5.080E+01
18.521	5.038E+01	18.854	4.927E+01	19.431	4.838E+01
19.534	4.737E+01	19.733	4.655E+01	20.258	4.501E+01
20.979	4.425E+01	21.573	4.373E+01	22.428	4.367E+01
23.173	4.181E+01	23.791	4.054E+01	24.341	4.005E+01
25.234	3.977E+01	25.866	3.928E+01	26.583	3.871E+01
27.333	3.831E+01	28.827	3.791E+01	29.834	3.738E+01
32.359	3.722E+01				


REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-17
ALUMINUM OXIDE FILM
T=300 K
SALAMA. J. ELECTROCHEM. SOC. 117, 913
(1970)
REF. 1R-17
REFLECTIVITY
WAVELENGTH(MICRONS)

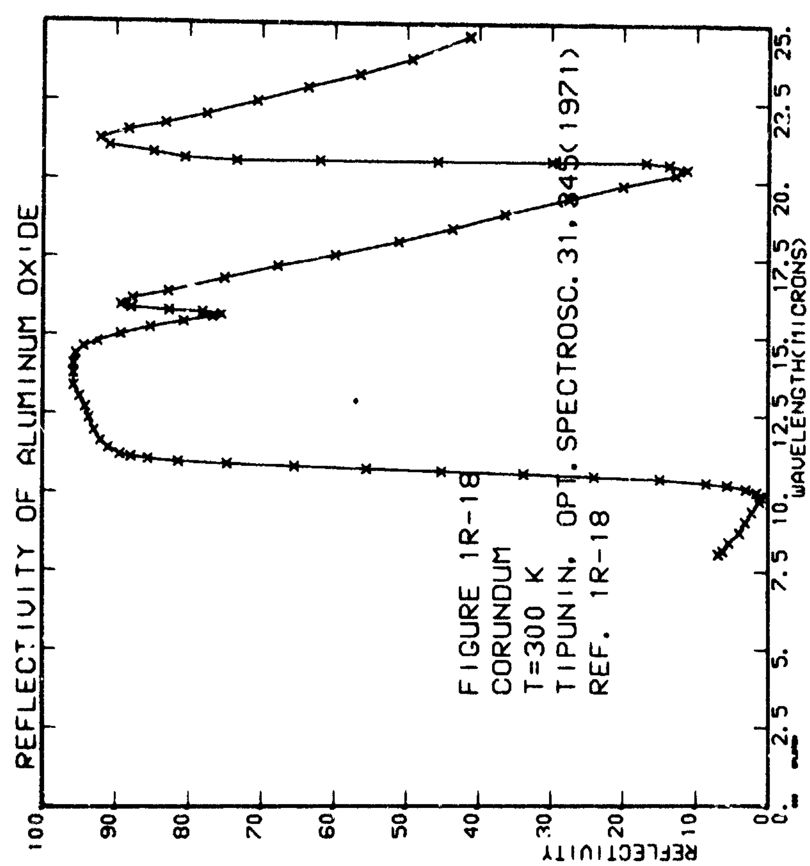

REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-17
ALUMINUM OXIDE FILM
T=300 K
SALAMA. J. ELECTROCHEM. SOC. 117, 913
(1970)
REF. 1R-17
REFLECTIVITY
WAVELENGTH(MICRONS)

Tipunin (Ref. IR-18)

The reflectivity of pure corundum from 2μ to 25μ with the optic axis perpendicular to the crystal reflecting surface was studied. Experimental details and error estimates were not given. The data were ditigized from a line.

These data were selected in part to construct the reflectivity spectrum of corundum given in Section I, Figure I-1.6.

λ	R	λ	R	λ	R
24.692	4.138E+01	23.894	4.931E+01	23.373	5.653E+01
22.948	[illegible].378E+01	22.520	7.070E+01	22.091	7.762E+01
21.739	8.322E+01	21.560	8.838E+01	21.283	9.221E+01
21.067	9.095E+01	20.862	8.491E+01	20.673	8.062E+01
20.614	7.352E+01	20.614	6.202E+01	20.614	4.577E+01
20.614	2.991E+01	20.614	1.693E+01	20.543	1.377E+01
20.380	1.137E+01	20.214	1.287E+01	19.849	2.009E+01
19.446	2.751E+01	18.928	3.640E+01	18.454	4.363E+01
18.024	5.116E+01	17.587	5.999E+01	17.238	6.789E+01
16.831	7.512E+01	16.406	8.280E+01	16.174	8.770E+01
15.984	8.934E+01	15.890	8.798E+01	15.821	8.279E+01
15.754	7.812E+01	15.693	7.557E+01	15.602	7.677E+01
15.458	8.073E+01	15.265	8.532E+01	15.046	8.938E+01
14.816	9.251E+01	14.627	9.443E+01	14.403	9.552E+01
14.092	9.583E+01	13.791	9.583E+01	13.376	9.582E+01
13.033	9.506E+01	12.715	9.426E+01	12.362	9.374E+01
11.955	9.305E+01	11.637	9.211E+01	11.410	9.103E+01
11.220	8.944E+01	11.130	8.798E+01	11.055	8.564E+01
10.991	8.142E+01	10.934	7.479E+01	10.831	6.558E+01
10.758	5.556E+01	10.668	4.512E+01	10.612	3.371E+01
10.538	2.401E+01	[illegible].454	1.496E+01	10.347	8.571E+00
10.273	5.623E+00	[illegible].172	3.117E+00	10.057	1.675E+00
9.941	1.159E+00	9.794	1.286E+00	9.441	2.377E+00
9.102	3.260E+00	8.758	4.065E+00	8.467	5.429E+00
8.173	6.208E+00	8.074	6.831E+00		



REFLECTIVITY OF ALUMINUM OXIDE
FIGURE 1R-18
CORUNDUM
T=300 K
TIPUNIN. OPT. SPECTROSC. 31. 345(1971)
REF. 1R-18
REFLECTIVITY
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

III-1.6 Tabulated Transmittance Data-Aluminum Oxide

Contents:

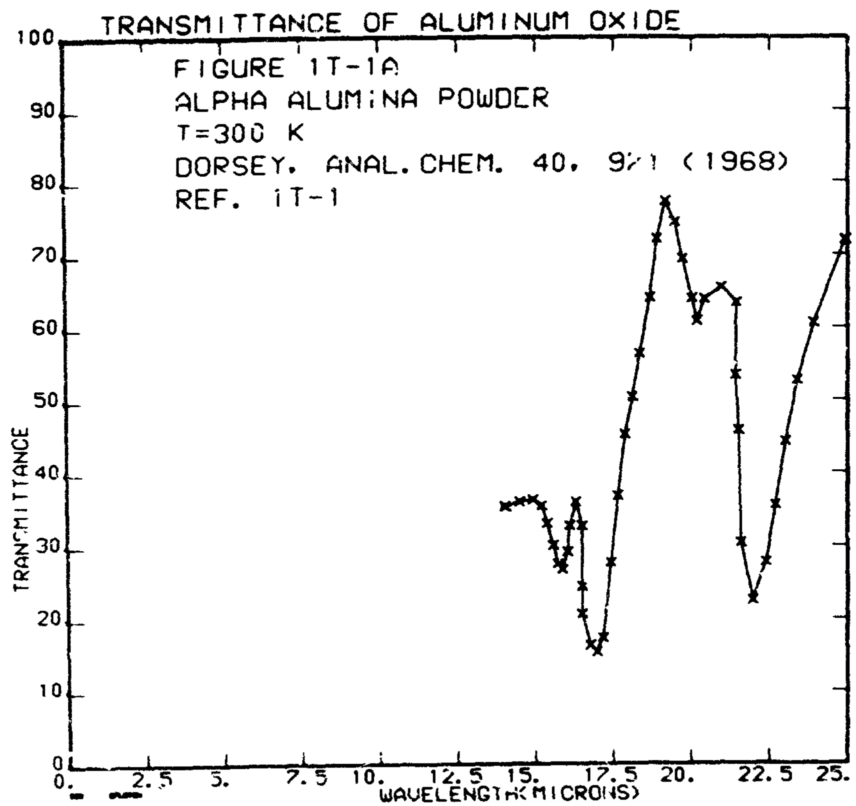
Dorsey (Ref. 1T-1)

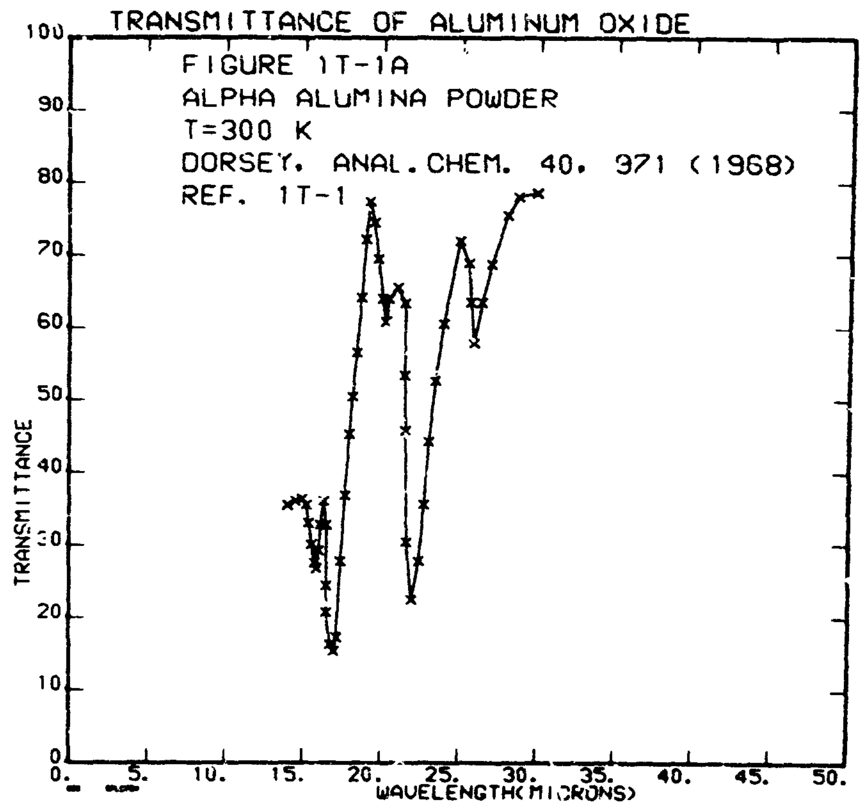
Alpha, g: m na, and pseudogamma alumina powders were studied using a Beckman IR-7 and an IR-11 spectrophotometer. No error analysis was given. Powders were incorporated into KBr pellets or polyethylene sheets. Data were taken from curves.

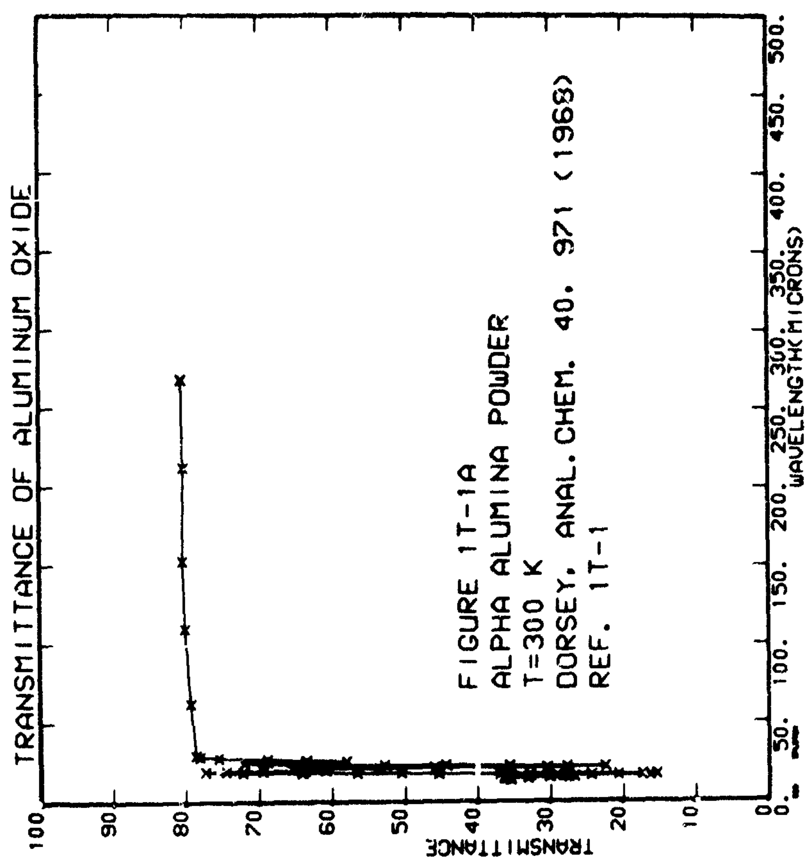
These data were selected in part for the representative curve, Figure I - 1.6d of Section I - 1.6.

a. α - Al_2O_3

λ	T	λ	T	λ	T
14.037	3.553E+01	14.517	3.609E+01	14.940	3.648E+01
15.209	3.560E+01	15.376	3.315E+01	15.585	3.009E+01
15.747	2.757E+01	15.873	2.676E+01	16.037	2.922E+01
15.105	3.280E+01	16.315	3.609E+01	16.503	3.280E+01
16.522	2.448E+01	16.522	2.073E+01	16.773	1.638E+01
16.395	1.547E+01	17.190	1.733E+01	17.430	2.778E+01
17.571	3.630E+01	17.837	4.532E+01	18.123	5.058E+01
18.351	5.658E+01	18.677	6.415E+01	18.899	7.222E+01
19.189	7.745E+01	19.476	7.450E+01	19.723	6.955E+01
20.033	6.401E+01	20.209	6.096E+01	20.440	6.391E+01
20.985	6.552E+01	21.464	6.342E+01	21.447	5.342E+01
21.523	4.584E+01	21.601	3.048E+01	21.990	2.255E+01
22.402	2.774E+01	22.712	3.567E+01	23.040	4.434E+01
23.416	5.272E+01	23.933	6.065E+01	24.931	7.204E+01
25.496	6.892E+01	25.678	6.352E+01	25.875	5.791E+01
26.362	6.356E+01	26.981	6.889E+01	27.967	7.555E+01
28.651	7.815E+01	29.874	7.860E+01	62.488	7.934E+01
110.282	8.001E+01	153.163	8.032E+01	212.658	8.079E+01
258.916	8.043E+01				


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-1A
ALPHA ALUMINA POWDER
T=300 K
DORSEY. ANAL.CHEM. 40. 971 (1968)
REF. 1T-1
TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-1A
ALPHA ALUMINA POWDER
T=300 K
DORSEY. ANAL.CHEM. 40. 371 (1968)
REF. 1T-1
TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-1A
ALPHA ALUMINA POWDER
T=300 K
DORSEY, ANAL.CHEM. 40. 971 (1968)
REF. 1T-1
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.

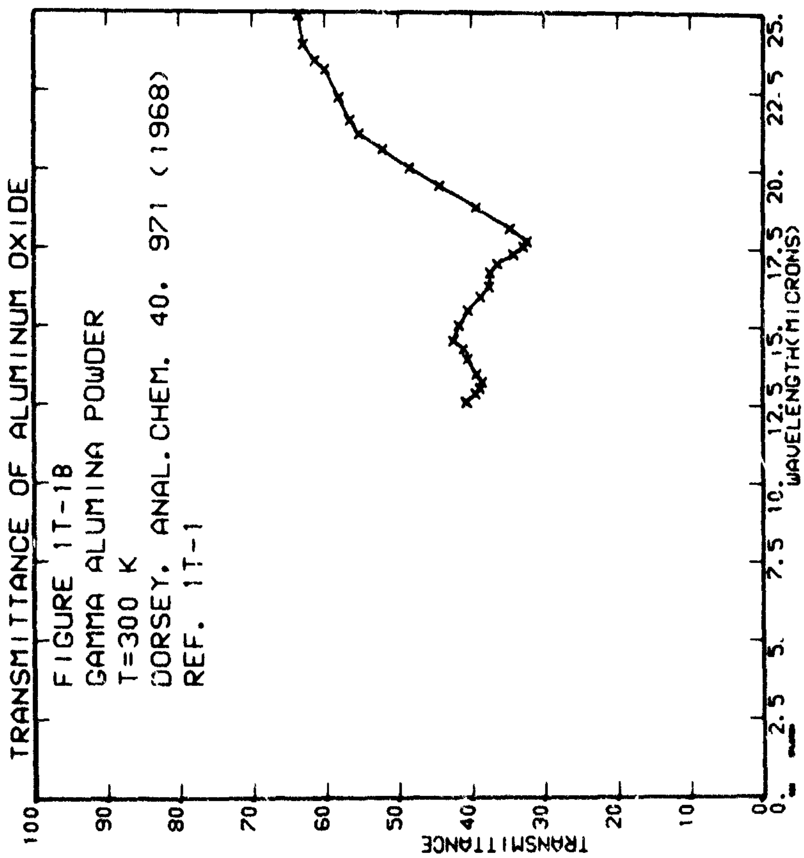
Dorsey (1T-1)

b. $\gamma - Al_2O_3$

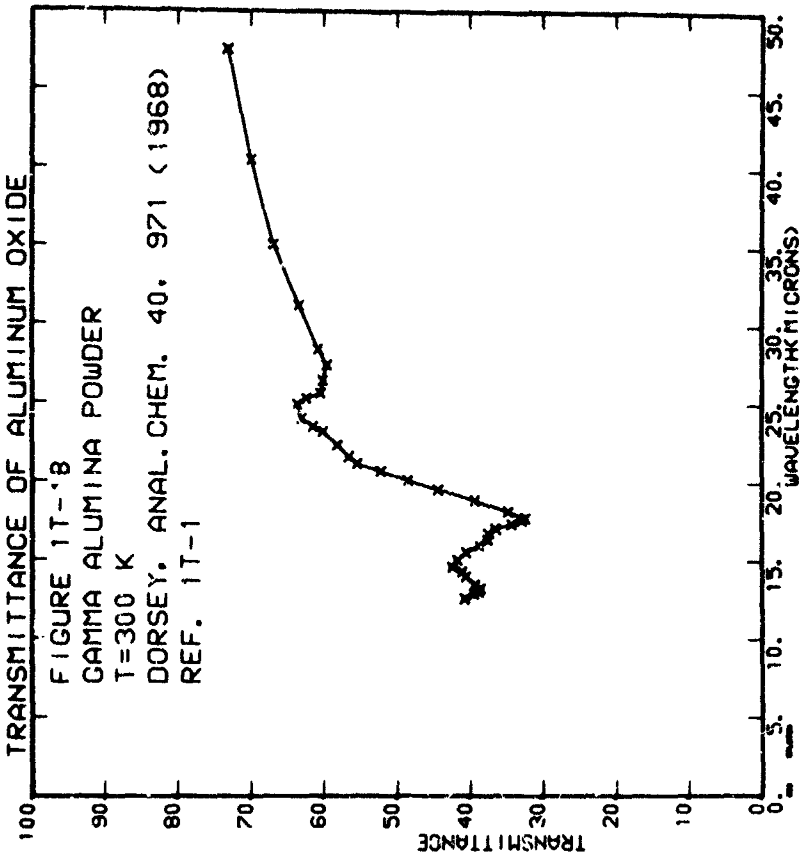
λ	T	λ	T	λ	T
12.586	4.078E+01	12.854	3.949E+01	13.032	3.881E+01
13.238	3.855E+01	13.485	3.938E+01	13.948	4.068E+01
14.274	4.118E+01	14.558	4.240E+01	15.029	4.179E+01
15.515	4.057E+01	15.951	3.877E+01	16.297	3.751E+01
16.735	3.748E+01	17.022	3.644E+01	17.314	3.428E+01
17.553	3.284E+01	17.745	3.230E+01	18.130	3.478E+01
18.799	3.931E+01	19.507	4.430E+01	20.069	4.851E+01
20.650	5.210E+01	21.142	5.541E+01	21.587	5.663E+01
22.311	5.810E+01	23.195	6.008E+01	23.455	6.148E+01
23.933	6.313E+01	24.913	6.378E+01	25.289	6.249E+01
25.644	6.040E+01	26.408	6.011E+01	27.396	5.950E+01
28.435	6.076E+01	31.242	6.353E+01	35.102	6.694E+01
40.522	7.007E+01	47.569	7.323E+01	59.395	7.668E+01
74.045	7.844E+01	84.357	8.056E+01	100.995	8.261E+01
127.053	8.354E+01	140.144	8.415E+01	162.553	8.419E+01
202.118	8.412E+01	226.230	8.390E+01	255.377	8.354E+01
288.541	8.300E+01				

c. Pseudo-$\gamma - Al_2O_3$

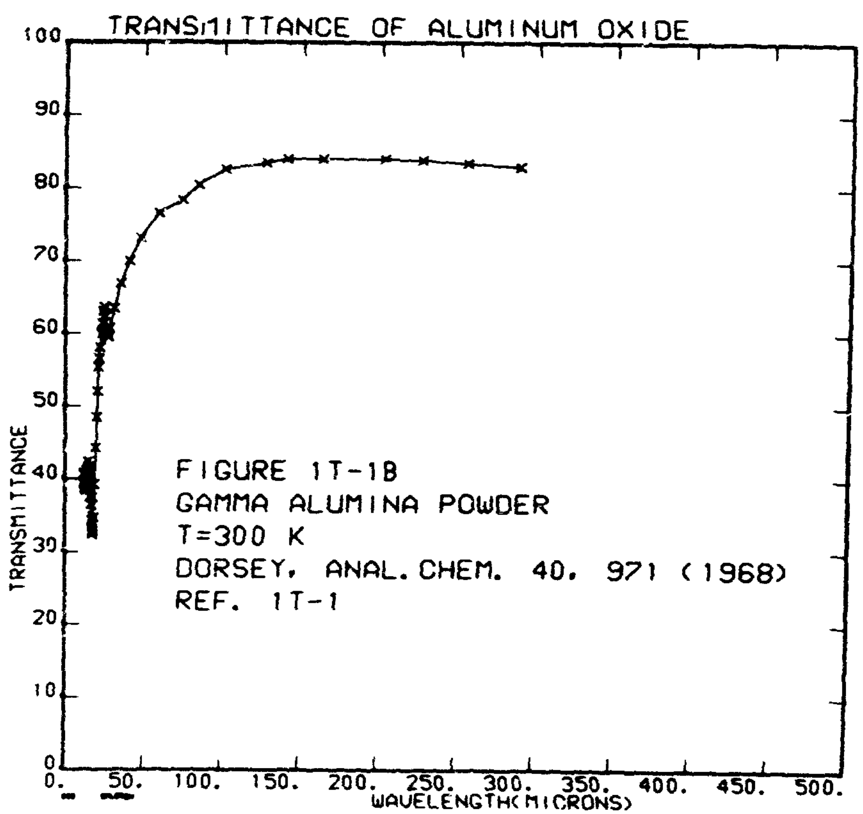
λ	T	λ	T	λ	T
12.571	3.165E+01	12.760	3.055E+01	12.980	3.000E+01
13.261	3.013E+01	13.607	3.127E+01	14.088	3.200E+01
14.475	3.238E+01	14.911	3.165E+01	15.389	3.051E+01
15.748	2.896E+01	15.947	2.661E+01	16.221	2.406E+01
16.527	2.330E+01	16.827	2.292E+01	17.383	2.496E+01
17.582	2.655E+01	18.395	2.927E+01	19.633	3.324E+01
[illegible]	3.718E+01	21.445	4.135E+01	22.603	4.536E+01
[illegible]	4.781E+01	24.106	4.991E+01	24.790	4.953E+01
24.852	4.978E+01	25.382	4.867E+01	25.656	4.846E+01
26.397	4.953E+01	27.293	5.033E+01	27.987	5.216E+01
28.800	5.399E+01	30.007	5.450E+01	30.864	5.547E+01
32.651	5.744E+01	34.640	5.996E+01	37.909	6.300E+01
41.021	6.565E+01	46.327	6.807E+01	50.670	6.976E+01
56.282	7.153E+01	63.905	7.325E+01	71.925	7.421E+01
75.500	7.508E+01	82.332	7.625E+01	88.677	7.739E+01
97.104	7.763E+01	110.820	7.808E+01	127.889	7.794E+01
140.865	7.770E+01	161.808	7.742E+01	184.966	7.677E+01
222.965	7.715E+01	291.221	7.660E+01		

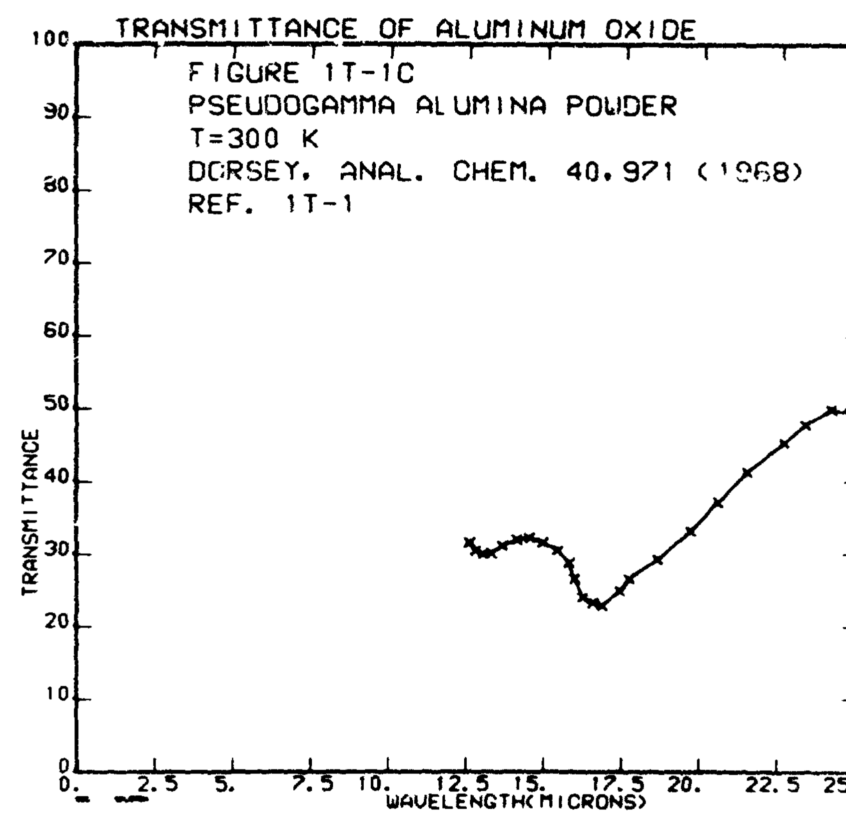


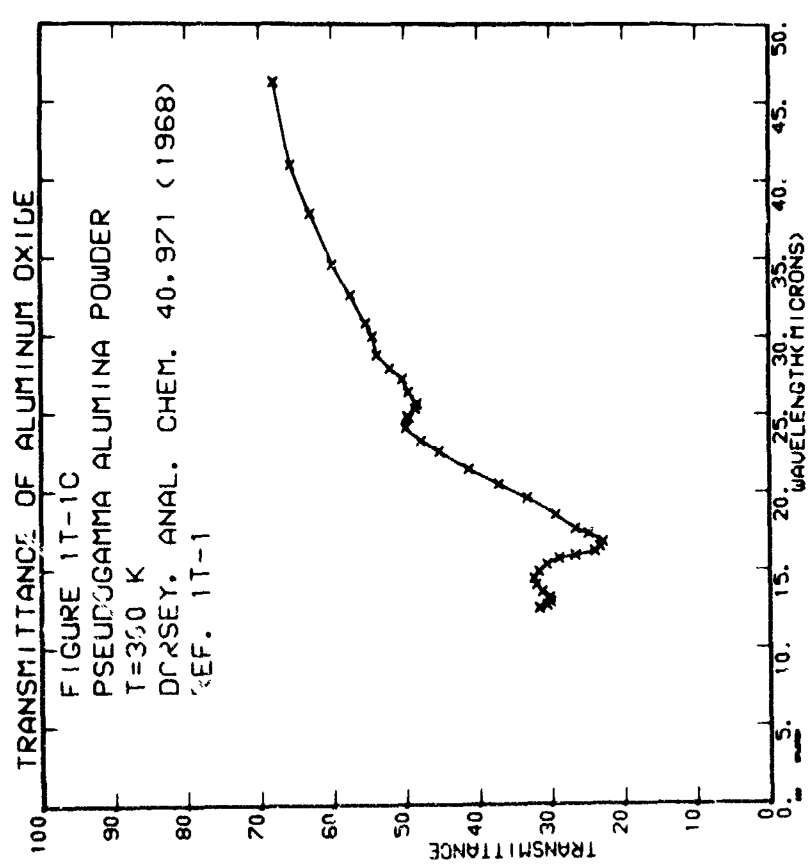
TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-1B
GAMMA ALUMINA POWDER
T=300 K
DORSEY, ANAL. CHEM. 40. 971 (1968)
REF. 1T-1
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

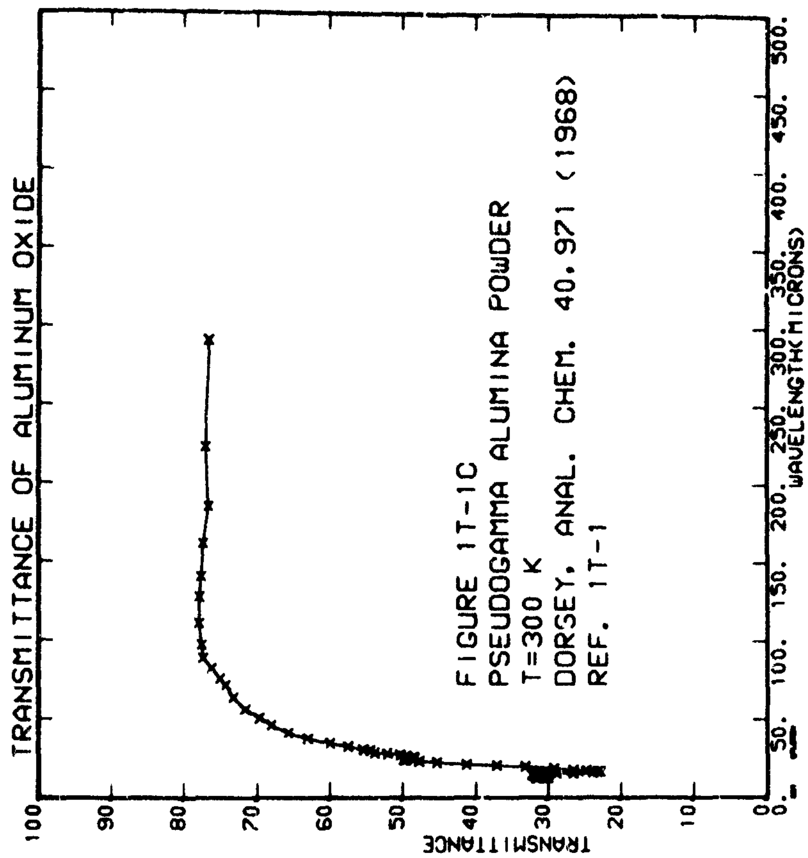


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-1B
GAMMA ALUMINA POWDER
T=300 K
DORSEY, ANAL. CHEM. 40. 971 (1968)
REF. 1T-1
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-1B
GAMMA ALUMINA POWDER
T=300 K
DORSEY, ANAL. CHEM. 40, 971 (1968)
REF. 1T-1
TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-1C
PSEUDOGAMMA ALUMINA POWDER
T=300 K
DORSEY, ANAL. CHEM. 40, 971 (1968)
REF. 1T-1
TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-1C
PSEUDOGAMMA ALUMINA POWDER
T=300 K
DORSEY. ANAL. CHEM. 40.971 (1968)
REF. 1T-1
TRANSMITTANCE
0 10 20 30 40 50 60 70 80 90 100
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-1C
PSEUDOGAMMA ALUMINA POWDER
T=300 K
DORSEY. ANAL. CHEM. 40.971 (1968)
REF. 1T-1
TRANSMITTANCE
0 10 20 30 40 50 60 70 80 90 100
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.

Gillespie (Ref. 1T-3)

The transmittance of Linde sapphire was measured over a temperature range of 298°K to 673°K, from 2μ to 8μ. A Perkin-Elmer 21 spectrophotometer with NaCl optics was used. No bandpass or error information was given. Data were digitized from curves.

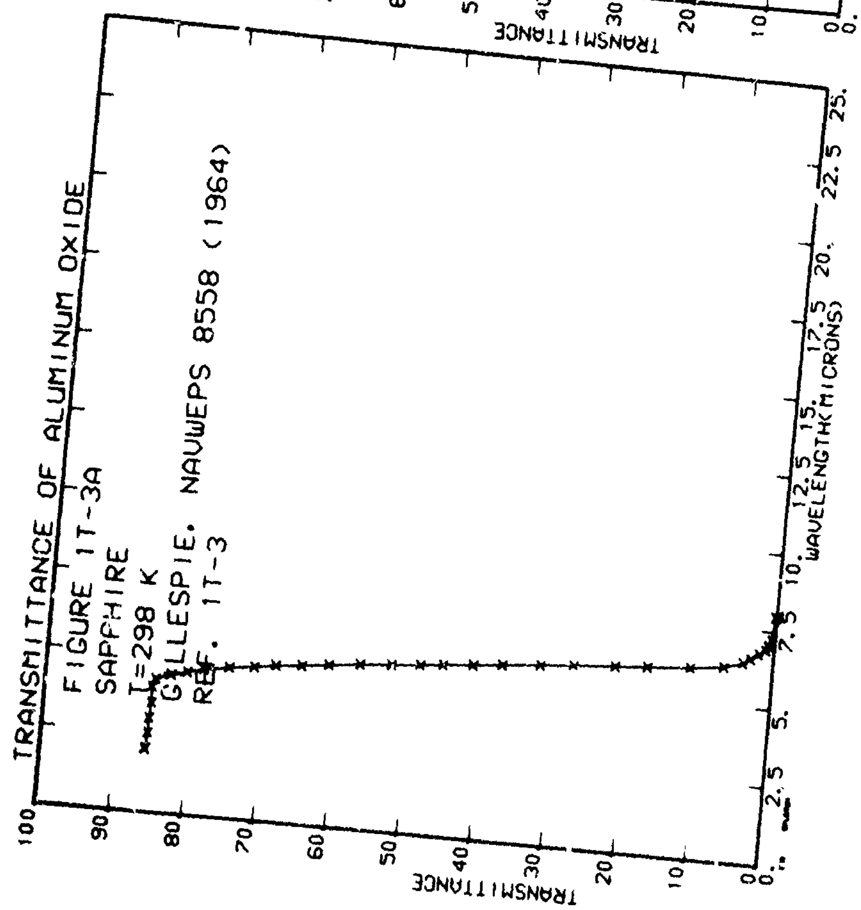
These data agree generally with the representative curve given in Section I - 1.6.

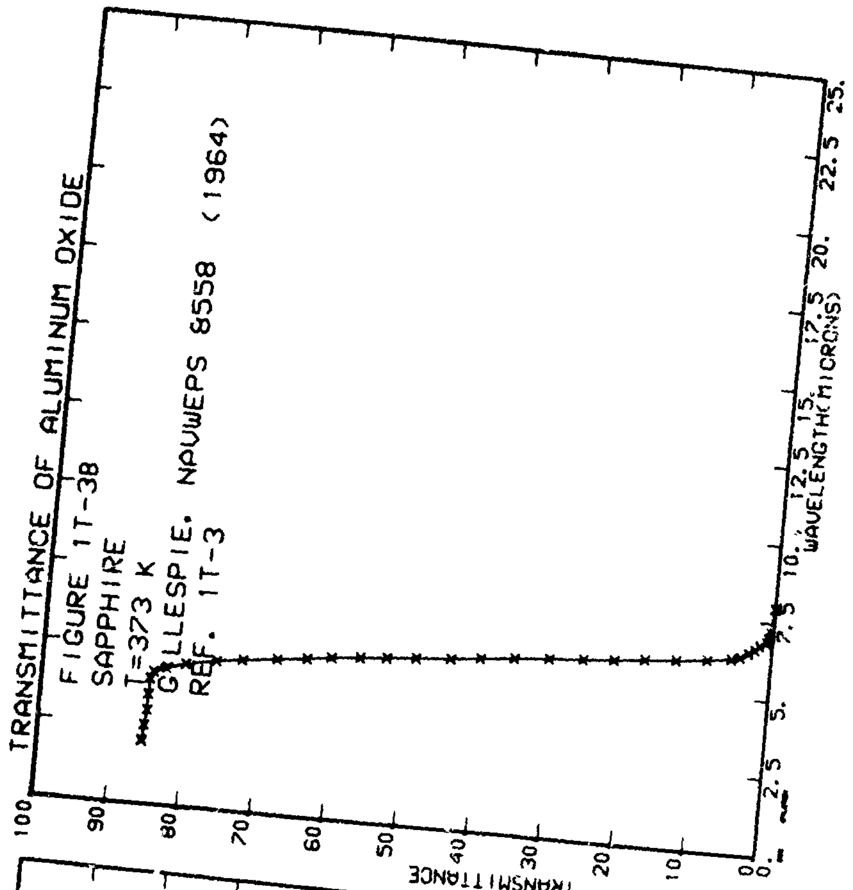
a. T = 298°K

λ	T	λ	T	λ	T	λ	T
2.031	85.651	2.507	85.411	2.991	85.451	3.492	85.281
3.982	83.311	4.234	84.920	4.411	82.936	4.545	80.752
4.654	73.293	4.788	74.992	4.895	71.538	4.975	68.595
5.[illegible]	65.038	5.158	61.247	5.254	57.020	5.342	52.684
5.435	48.721	5.483	45.519	5.570	41.455	5.655	37.355
5.757	32.167	5.854	27.572	5.970	21.770	6.045	17.389
6.144	11.423	5.250	6.721	6.428	4.182	6.590	3.182
6.751	2.03[illegible]	6.910	1.163	7.061	.806	7.266	.428
7.995	.[illegible]92						

b. T = 373°K

λ	T	λ	T	λ	T	λ	T
[illegible]	[illegible]	[illegible]	85.[illegible]11	2.992	85.22[illegible]	3.496	85.230
[illegible]	[illegible]	[illegible]	[illegible]	4.35[illegible]	83.[illegible]	4.52[illegible]	8[illegible].391
[illegible]	[illegible]	[illegible]	[illegible]	4.93[illegible]	67.[illegible]92	4.[illegible]35	63.363
[illegible]	[illegible]21	[illegible]	[illegible]	5.27[illegible]	52.93[illegible]	5.349	48.931
[illegible]	[illegible]	[illegible]	[illegible]	5.627	35.39[illegible]	5.723	30.[illegible]98
[illegible]	2[illegible].9[illegible]3	[illegible]	21.[illegible]	5.99[illegible]	17.[illegible]	6.[illegible]68	13.[illegible]95
[illegible]	[illegible]	[illegible]	[illegible]43	6.34[illegible]	4.25[illegible]	6.477	3.151
[illegible]	2.23[illegible]	[illegible]	1.[illegible]13	6.892	.88[illegible]	7.011	.571
.2[illegible]	.39[illegible]	.98[illegible]	.[illegible]41				


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-3A
SAPPHIRE
T=298 K
GILLESPIE. NAVWEPS 8558 (1964)
REF. 1T-3
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-3B
SAPPHIRE
T=373 K
GILLESPIE. NAVWEPS 8558 (1964)
REF. 1T-3
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Gillespie (Ref. 1T-3)

c. T = 473°K

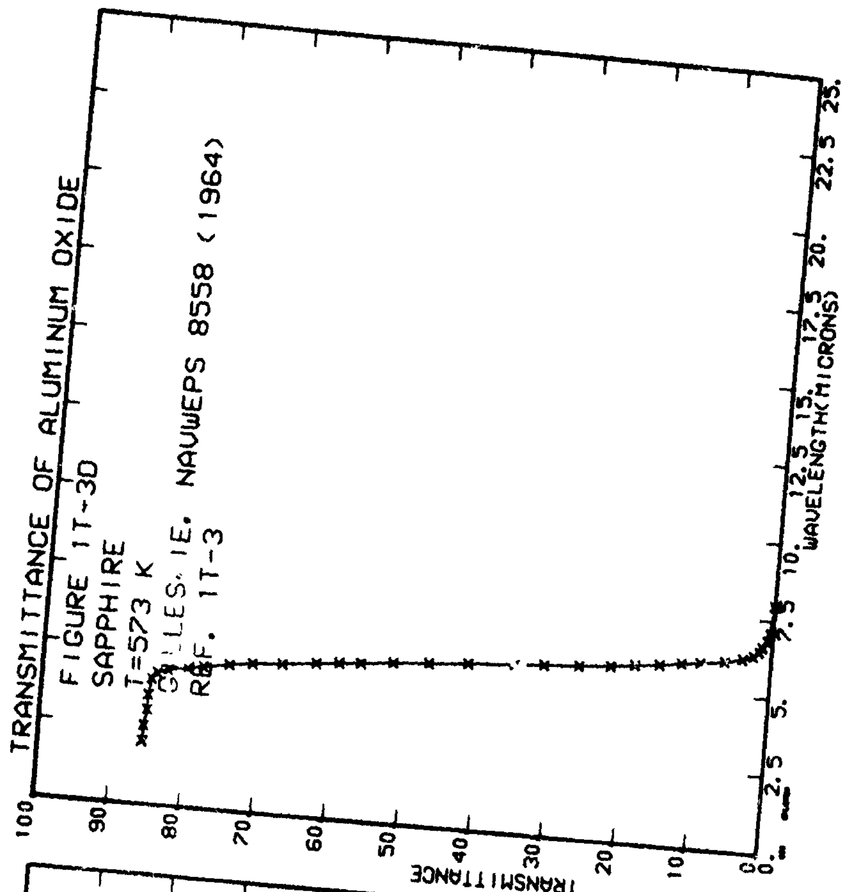
λ	T	λ	T	λ	T	λ	T
2.[illegible]	[illegible]	2.[illegible]93	[illegible]	2.391	85.21[illegible]	3.[illegible]92	85.210
[illegible]	[illegible]	[illegible]	[illegible]	[illegible].331	83.22[illegible]	[illegible].475	80.411
4.[illegible]	[illegible].293	[illegible].583	[illegible]	[illegible].77[illegible]	71.96[illegible]	[illegible].562	67.359
[illegible]	[illegible]	[illegible]	37.[illegible]	[illegible].21[illegible]	52.[illegible]	[illegible].326	45.539
[illegible]	[illegible]	[illegible]	3[illegible].423	[illegible]	29.[illegible]23	[illegible].712	25.370
[illegible]	2[illegible]	[illegible]	[illegible].247	[illegible].383	3.[illegible]	[illegible]	6.303
6.221	[illegible].37[illegible]	[illegible]	[illegible]	6.[illegible]	2.379	6.510	2.285
[illegible].779	1.122	[illegible].911	.653	7.15[illegible]	.52[illegible]	7.992	.122

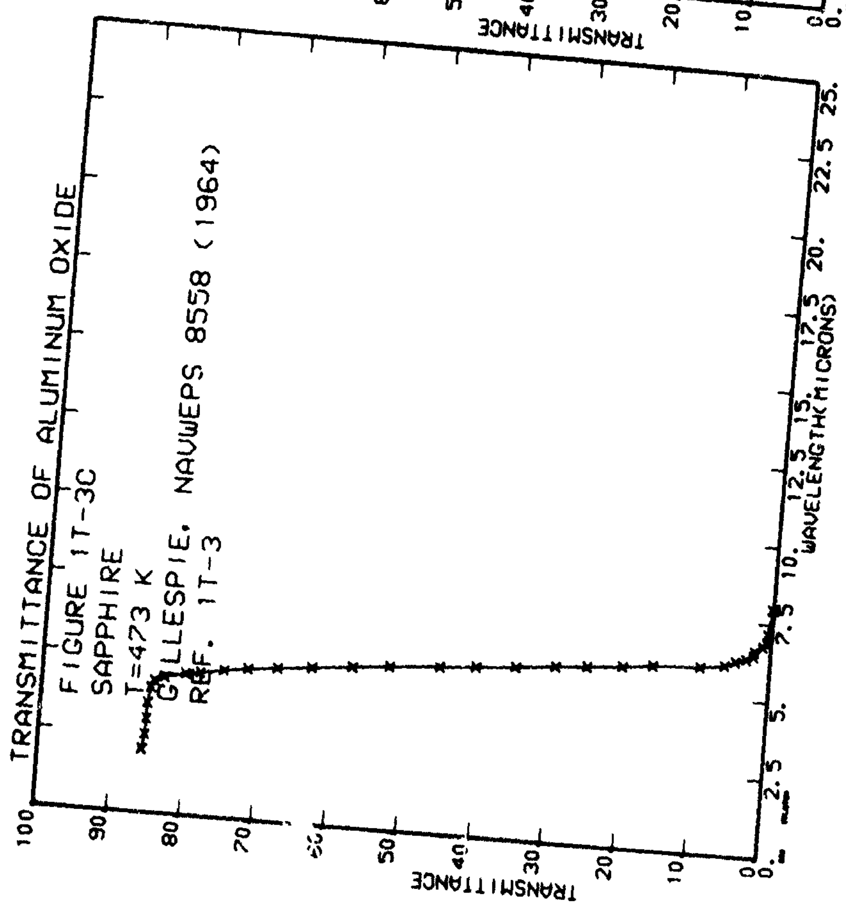
d. T = 573°K

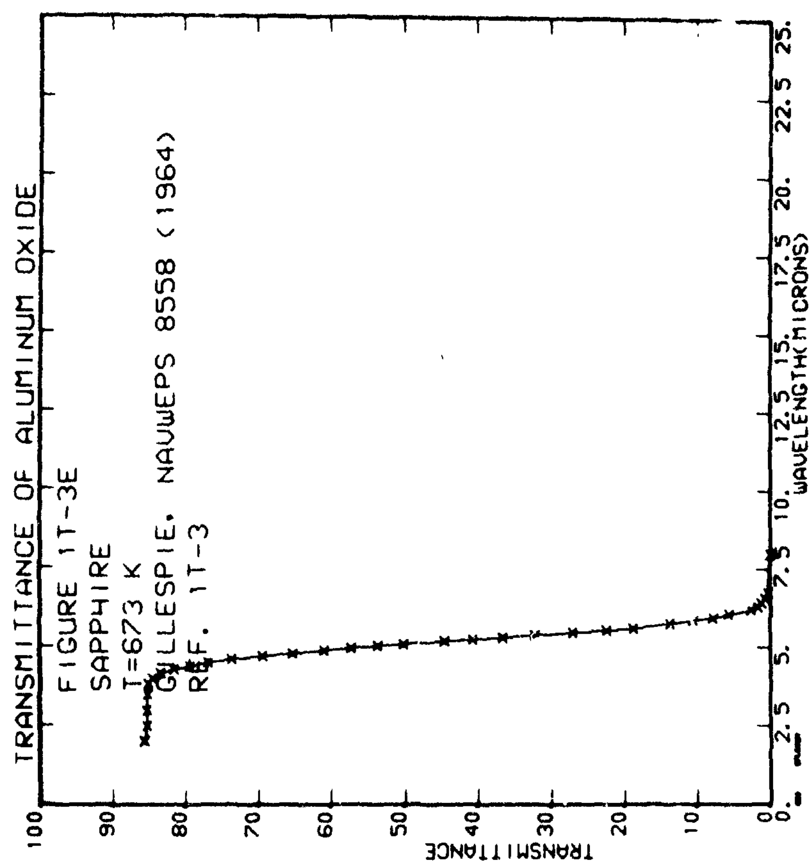
λ	T	λ	T	λ	T	λ	T
[illegible]	[illegible]	[illegible]	[illegible].531	3.[illegible]22	85.2[illegible]	3.[illegible]92	85.210
[illegible]	[illegible]	[illegible]	[illegible].330	[illegible].322	[illegible]	[illegible].42[illegible]	80.281
4.[illegible]	[illegible]	[illegible]	7[illegible]	[illegible].727	71.35[illegible]	[illegible].946	67.256
[illegible]	[illegible]	[illegible]	59.338	[illegible]	[illegible].408	[illegible]	52.[illegible]32
[illegible]	[illegible].1[illegible]	[illegible].327	[illegible].795	[illegible]	[illegible]	[illegible].78	31.292
[illegible]	12.3[illegible]	[illegible]	22.162	[illegible].723	18.[illegible]	[illegible].816	15.431
[illegible]	[illegible]	[illegible]	[illegible].639	[illegible]	[illegible]	6.2[illegible]	3.896
[illegible]	[illegible]	[illegible].391	.951	6.639	[illegible].3[illegible]	6.851	.734

e. T = 673°K

λ	T	λ	T	λ	T	λ	T
2.[illegible]	[illegible].571	[illegible]	[illegible].231	2.[illegible]	85.261	3.493	85.170
3.[illegible]	[illegible]	[illegible]	[illegible]	[illegible].1[illegible]	83.[illegible]	[illegible].288	81.503
[illegible]	[illegible]	[illegible]	7[illegible].911	[illegible]	[illegible].313	[illegible].71[illegible]	69.462
[illegible].93	[illegible].3[illegible]	[illegible]	[illegible]	[illegible].957	57.371	[illegible].825	53.688
[illegible]	[illegible]	[illegible].8[illegible]	[illegible]	[illegible].242	[illegible]	[illegible].313	36.591
[illegible].76[illegible]	1[illegible]	[illegible]	2[illegible].933	[illegible]	[illegible].443	[illegible].825	18.725
[illegible]	[illegible].7[illegible]	[illegible].314	1[illegible].925	[illegible]	[illegible].833	[illegible]	[illegible].762
6.[illegible]	.31[illegible]	[illegible].393	1.734	[illegible].43[illegible]	1.234	6.896	.755
			.[illegible]51				


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-3D
SAPPHIRE
T=573 K
GILLESPIE, NAVWEPS 8558 (1964)
REF. 1T-3
TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-3C
SAPPHIRE
T=473 K
GILLESPIE, NAVWEPS 8558 (1964)
REF. 1T-3
TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-3E
SAPPHIRE
T=673 K
GILLESPIE, NAVWEPS 8558 (1964)
REF. 1T-3
TRANSMITTANCE
WAVELENGTH(MICRONS)
100
90
80
70
60
50
40
30
20
10
0
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.

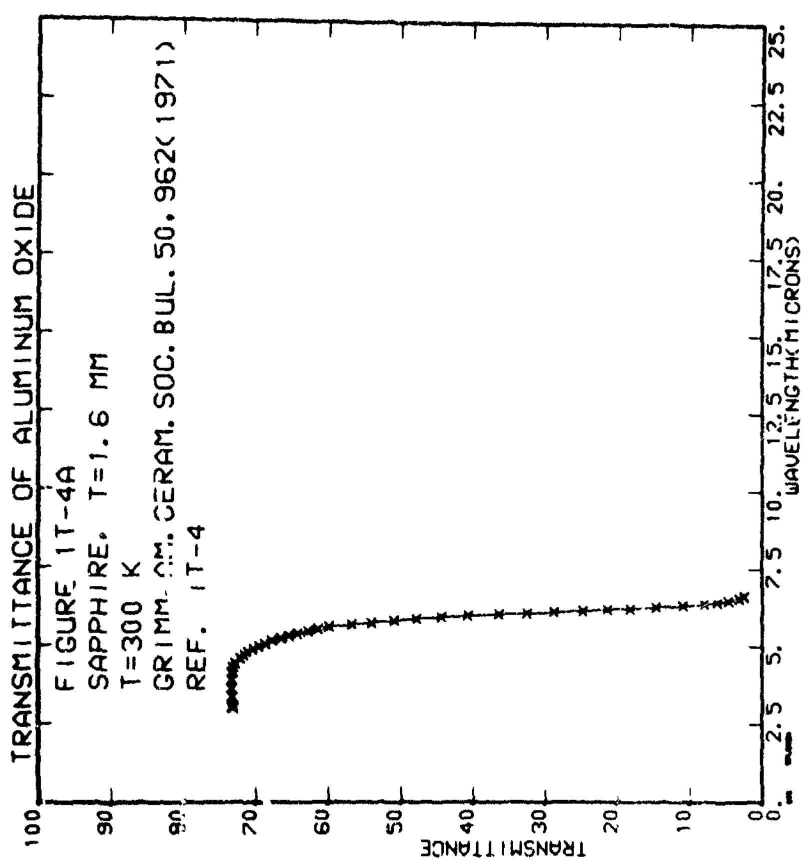
Grimm (Ref. 1T-4)

The transmittance of synthetic sapphire and General Electric Lucalox high density polycrystalline alumina with 0.2 percent MgO content, a density of 3.975 g/cm^3, and grain size of 27 $\pm$ 3μ was measured on a Perkin-Elmer 337 double beam spectrophotometer with an undisclosed bandpass. No error analysis or temperature was given. Data were digitized from a curve.

These data are in general agreement with the representative curve given in Section I - 1.6.

a. Synthetic sapphire 6 mm thick, surface finish of < 5μ in.

λ	T	λ	T	λ	T	λ	T
3.000	73.349	3.000	73.221	3.095	73.328	3.352	73.397
3.598	73.424	3.917	73.403	4.134	73.339	4.299	73.221
4.431	72.891	4.580	72.251	4.685	71.760	4.780	71.215
4.890	70.464	4.984	69.643	5.072	68.741	5.159	67.808
5.235	66.683	5.309	65.525	5.381	64.315	5.457	62.880
5.530	61.456	5.601	59.936	5.675	56.791	5.735	54.072
5.802	50.938	5.870	47.889	5.932	44.467	5.979	40.714
6.024	36.452	6.064	32.510	6.108	28.830	6.153	24.800
6.202	21.395	6.244	18.356	6.289	14.740	6.333	11.058
6.374	8.077	6.425	6.214	6.495	4.723	6.569	3.244
5.538	2.532						



TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-4A
SAPPHIRE, T=1.6 MM
T=300 K
GRIMM. AM. CERAM. SOC. BUL. 50, 962(1971)
REF. 1T-4
TRANSMITTANCE
WAVELENGTH(MICRONS)
100 90 80 70 60 50 40 30 20 10 0
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

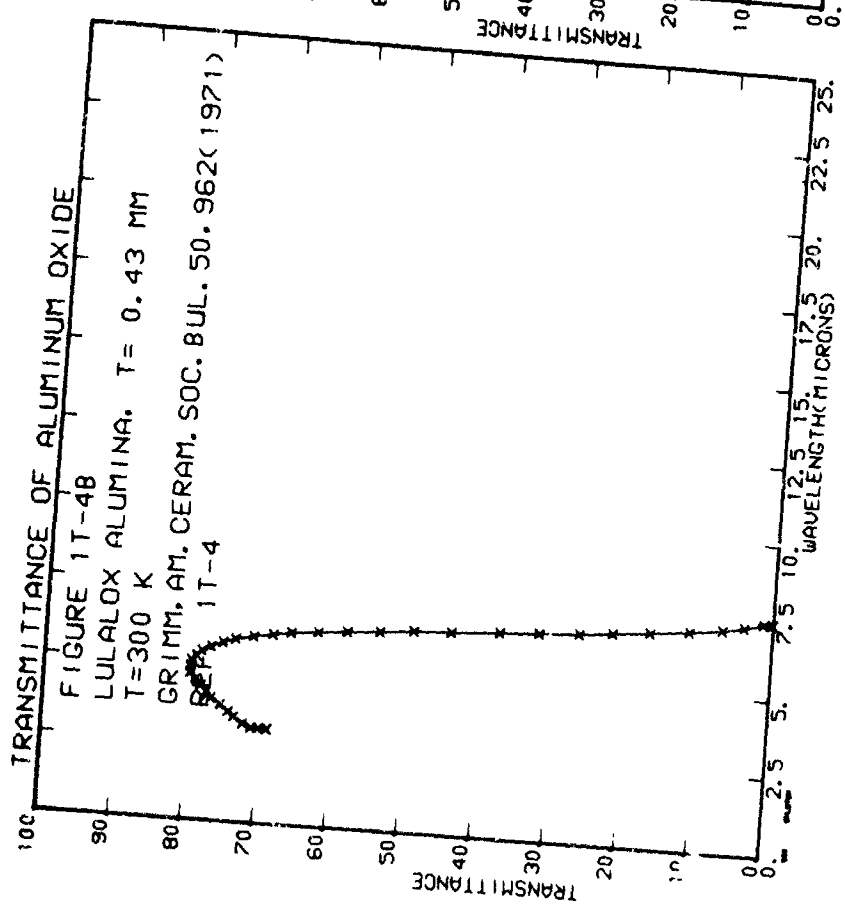
Grimm (Ref. 1T-4)

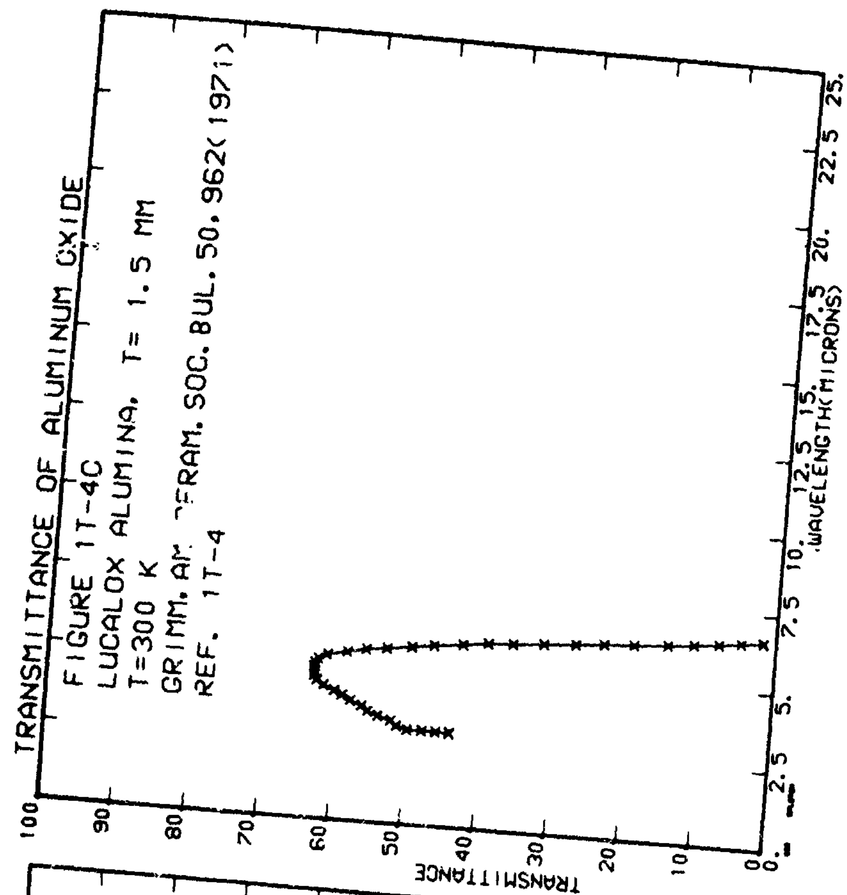
b. Lucalox alumina, 0.43 mm thick

λ	T	λ	T	λ	T	λ	T
3.000	6.884E+01	3.000	7.004E+01	3.000	7.106E+01	3.147	7.228E+01
3.331	7.341E+01	3.491	7.426E+01	3.676	7.549E+01	3.897	7.681E+01
4.053	7.751E+01	4.266	7.837E+01	4.464	7.905E+01	4.631	7.979E+01
4.840	7.981E+01	5.031	7.972E+01	5.193	7.912E+01	5.359	7.846E+01
5.506	7.729E+01	5.651	7.556E+01	5.781	7.382E+01	5.905	7.143E+01
6.099	6.876E+01	6.099	6.623E+01	6.180	6.256E+01	6.269	5.856E+01
6.345	5.401E+01	6.433	4.931E+01	6.491	4.426E+01	6.582	3.760E+01
6.660	3.217E+01	6.746	2.655E+01	6.826	2.207E+01	6.936	1.680E+01
7.063	1.148E+01	7.195	6.941E+00	7.321	3.890E+00	7.448	1.327E+00
7.479	1.373E-01						

c. Lucalox alumina, 1.5 mm thick

λ	T	λ	T	λ	T	λ	T
3.000	4.411E+01	3.000	4.608E+01	3.000	4.789E+01	3.000	4.996E+01
3.099	5.139E+01	3.256	5.223E+01	3.390	5.403E+01	3.522	5.550E+01
3.661	5.646E+01	3.811	5.806E+01	3.961	5.929E+01	4.096	6.034E+01
4.236	6.183E+01	4.374	6.286E+01	4.528	6.327E+01	4.660	6.322E+01
4.791	6.331E+01	4.932	6.324E+01	5.061	6.286E+01	5.200	6.163E+01
5.335	5.899E+01	5.450	5.634E+01	5.546	5.346E+01	5.640	5.002E+01
5.737	4.7[illegible]3E+01	5.841	4.304E+01	5.929	3.962E+01	5.997	3.609E+01
6.065	3.190E+01	6.127	2.747E+01	6.199	2.363E+01	6.270	1.942E+01
6.336	1.481E+01	6.411	1.124E+01	6.481	7.841E+00	6.556	4.699E+00
6.633	1.785E+00						


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-4B
LULALOX ALUMINA. T= 0.43 MM
T=300 K
GRIMM, AM. CERAM. SOC. BUL. 50, 962(1971)
REF. 1T-4
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-4C
LUCALOX ALUMINA. T= 1.5 MM
T=300 K
GRIMM, AM. CERAM. SOC. BUL. 50, 962(1971)
REF. 1T-4
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

Harris (Ref. 1T-6)

The transmittance of 50, 100, and 200 volt aluminum oxide films from 14μ to 90μ were measured using a grating spectrometer. No estimates of error were given. Data are digitized from lines.

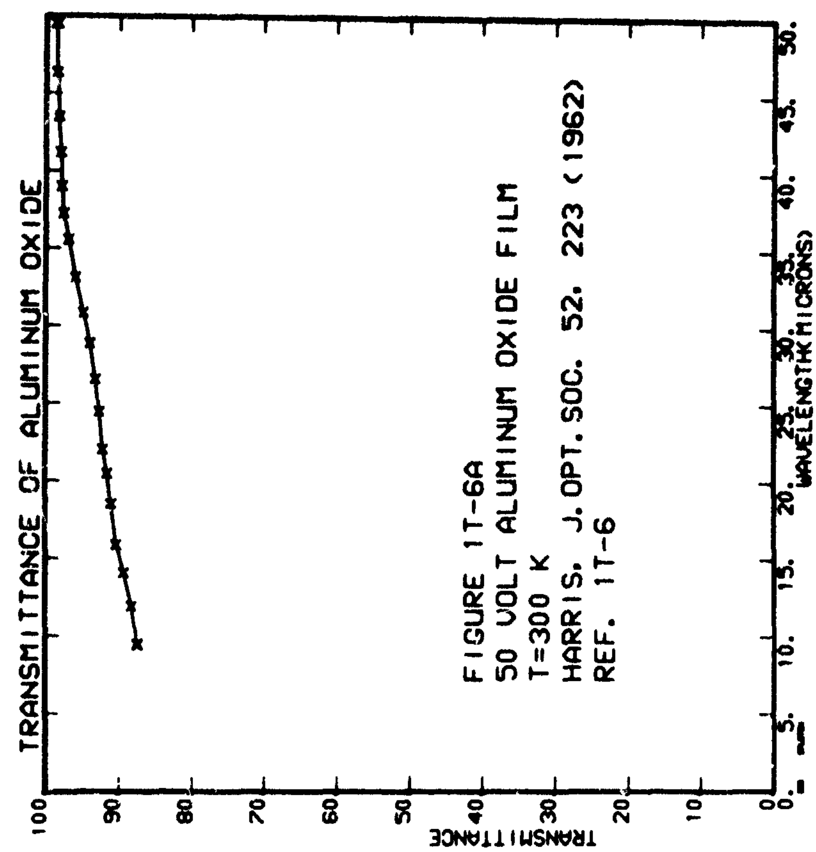
The data for thin films are not comparable to the sapphire or bulk alumina data.

a. 50 volt film

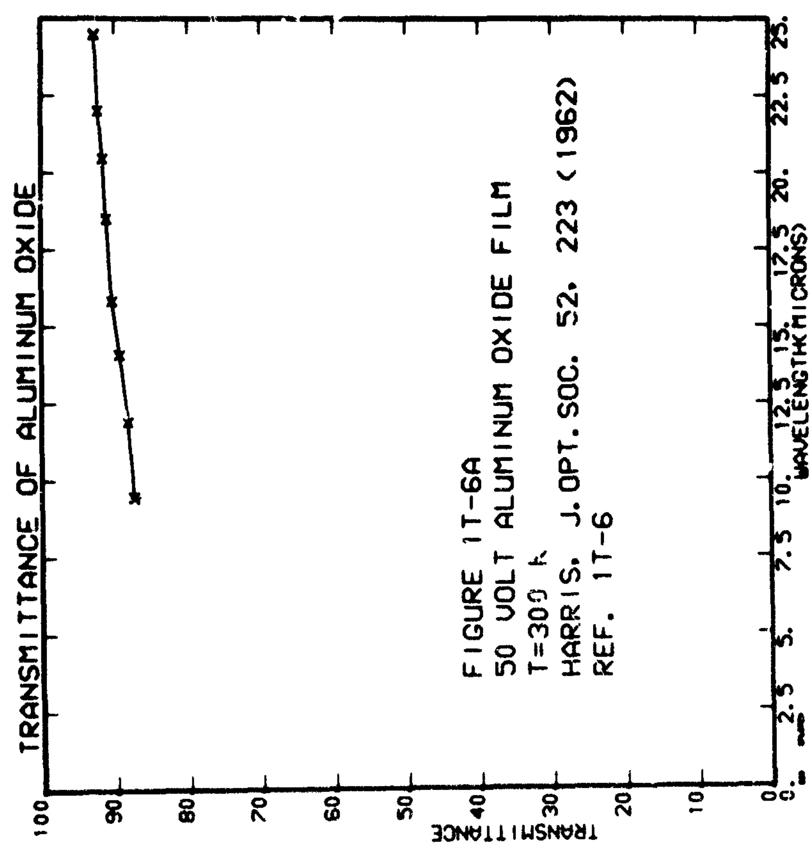
λ	T	λ	T	λ	T	λ	T
9.40[illegible]	8.757E+01	11.905	8.036E+01	14.090	8.944E+01	15.840	9.047E+01
10.5[illegible]1	9.11[illegible]E+01	20.468	9.101E+01	22.007	9.221E+01	24.493	9.276E+01
2[illegible].5[illegible]5	9.319E+01	26.348	9.462E+01	30.826	9.498E+01	33.136	9.600E+01
3[illegible].56[illegible]	9.7[illegible]3E+01	37.283	9.761E+01	39.018	9.790E+01	41.217	9.800E+01
43.511	9.832E+01	46.385	9.851E+01	49.513	9.861E+01	52.034	9.875E+01
50.613	9.875E+01	61.921	9.875E+01	69.018	9.890E+01	76.019	9.889E+01
54.303	9.858E+01	90.734	9.888E+01	95.364	9.901E+01	103.094	9.962E+01
1[illegible]8.135	9.917E+01	113.723	9.919E+01	118.372	9.918E+01		

b. 100 volt film

λ	T	λ	T	λ	T	λ	T
1[illegible].273	7.374E+01	12.555	7.415E+01	12.505	7.491E+01	13.512	7.574E+01
14.501	7.659E+01	15.139	7.745E+01	15.824	7.858E+01	16.681	7.347E+01
17.923	8.025E+01	19.122	8.083E+01	20.696	8.133E+01	22.036	8.165E+01
23.155	8.197E+01	25.706	8.255E+01	24.584	8.332E+01	25.576	8.396E+01
26.049	8.443E+01	27.925	8.562E+01	26.536	8.561E+01	29.247	8.660E+01
[illegible]	8.741E+01	30.703	8.835E+01	31.763	8.935E+01	32.868	8.981E+01
[illegible]	9.051E+01	35.056	9.170E+01	36.942	9.257E+01	38.482	9.342E+01
39.205	9.425E+01	40.209	9.485E+01	40.985	9.537E+01	43.696	9.552E+01
46.593	9.577E+01	49.005	9.597E+01	53.045	9.615E+01	57.136	9.635E+01
61.235	9.634E+01	65.027	9.681E+01	58.538	9.700E+01	71.826	9.715E+01
74.959	9.739E+01	77.303	9.752E+01	81.632	9.754E+01	83.906	9.754E+01
86.495	9.752E+01	90.335	9.761E+01	90.734	9.774E+01	93.401	9.756E+01
90.20[illegible]	9.733E+01						



TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-6A
50 VOLT ALUMINUM OXIDE FILM
T=300 K
HARRIS. J.OPT.SOC. 52. 223 (1962)
REF. 1T-6
TRANSMITTANCE
WAVELENGTH(MICRONS)



TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-6A
50 VOLT ALUMINUM OXIDE FILM
HARRIS. J.OPT.SOC. 52. 223 (1962)
REF. 1T-6
TRANSMITTANCE
WAVELENGTH(MICRONS)

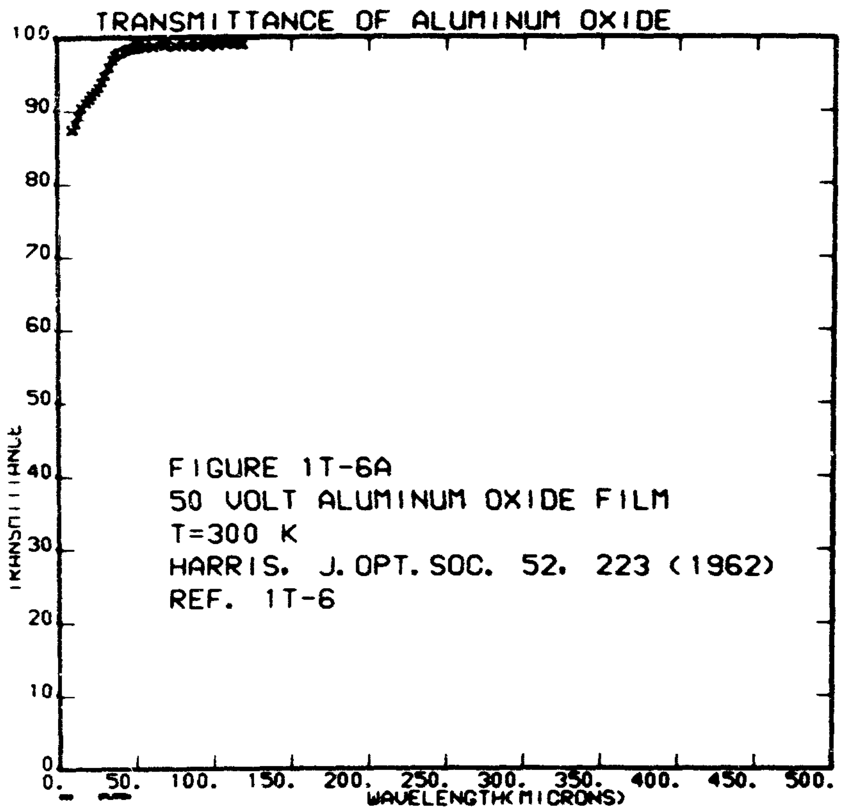


FIGURE 1T-6A
50 VOLT ALUMINUM OXIDE FILM
T=300 K
HARRIS. J. OPT. SOC. 52. 223 (1962)
REF. 1T-6

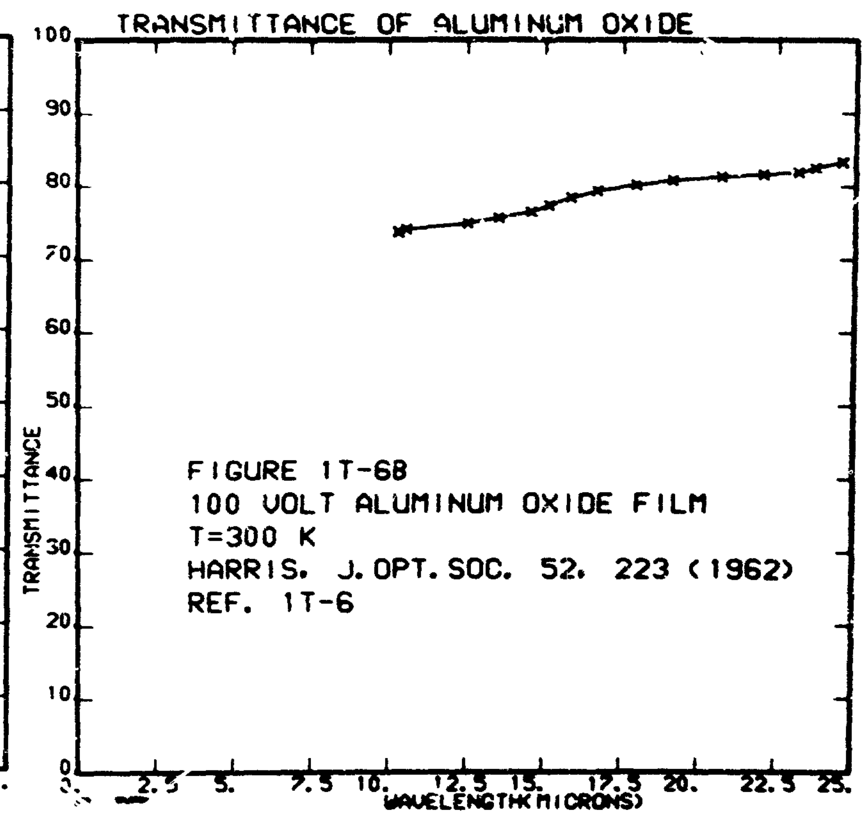
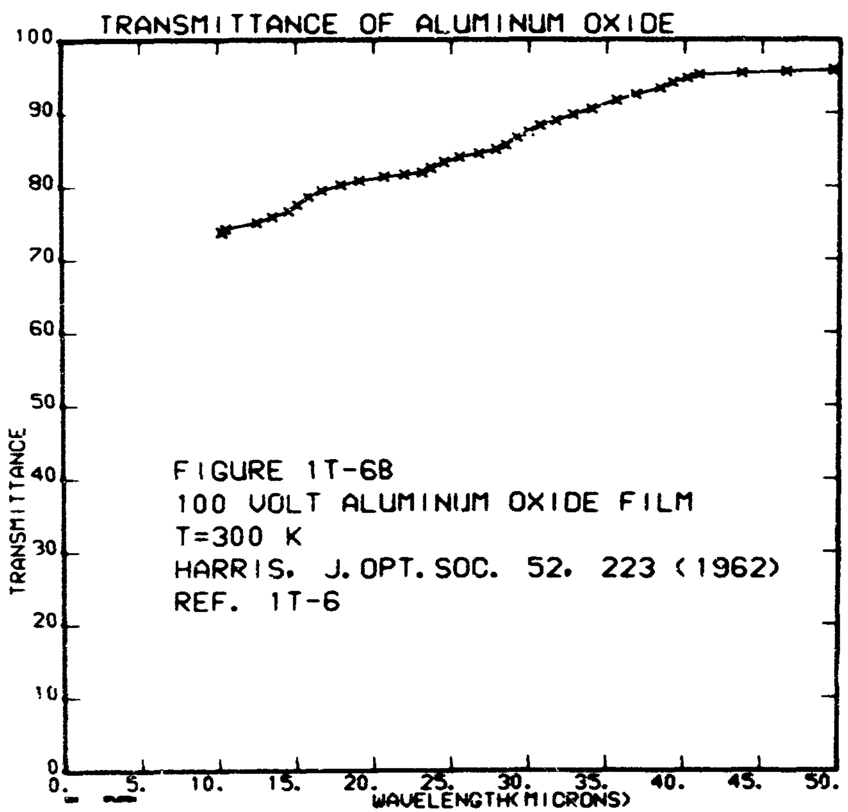
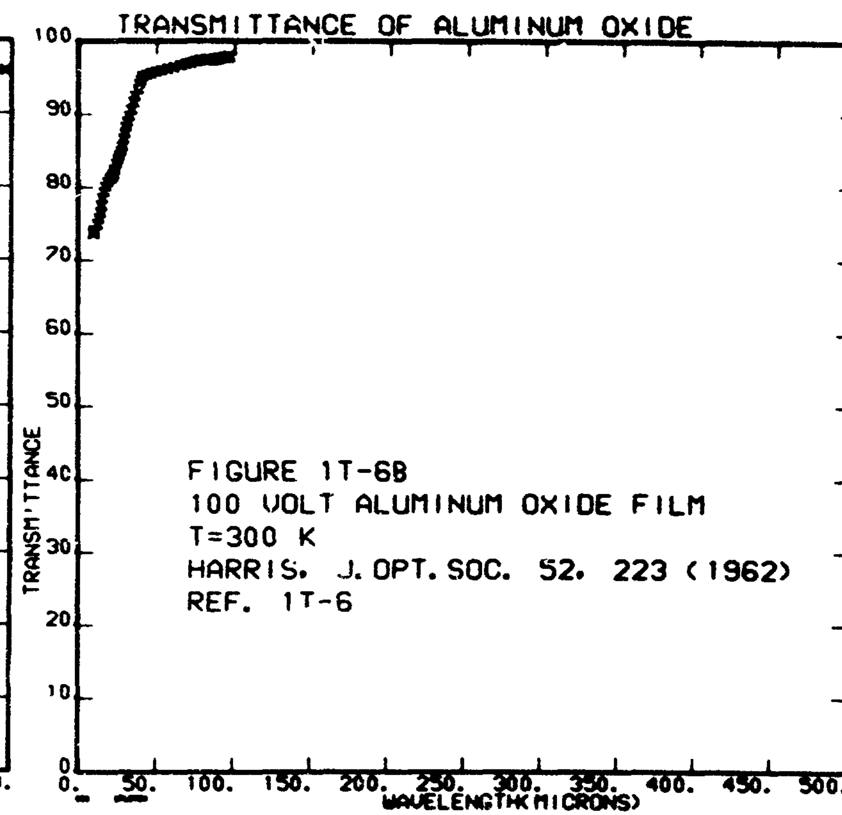


FIGURE 1T-6B
100 VOLT ALUMINUM OXIDE FILM
T=300 K
HARRIS. J. OPT. SOC. 52. 223 (1962)
REF. 1T-6

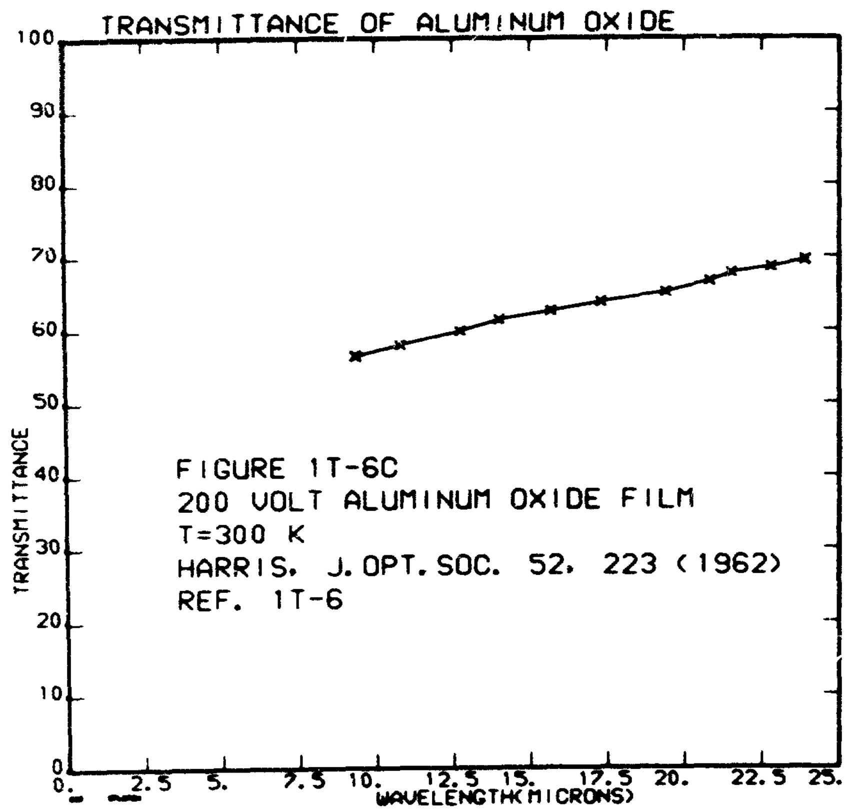

TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-6B
100 VOLT ALUMINUM OXIDE FILM
T=300 K
HARRIS. J. OPT. SOC. 52. 223 (1962)
REF. 1T-6
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.
0 10 20 30 40 50 60 70 80 90 100

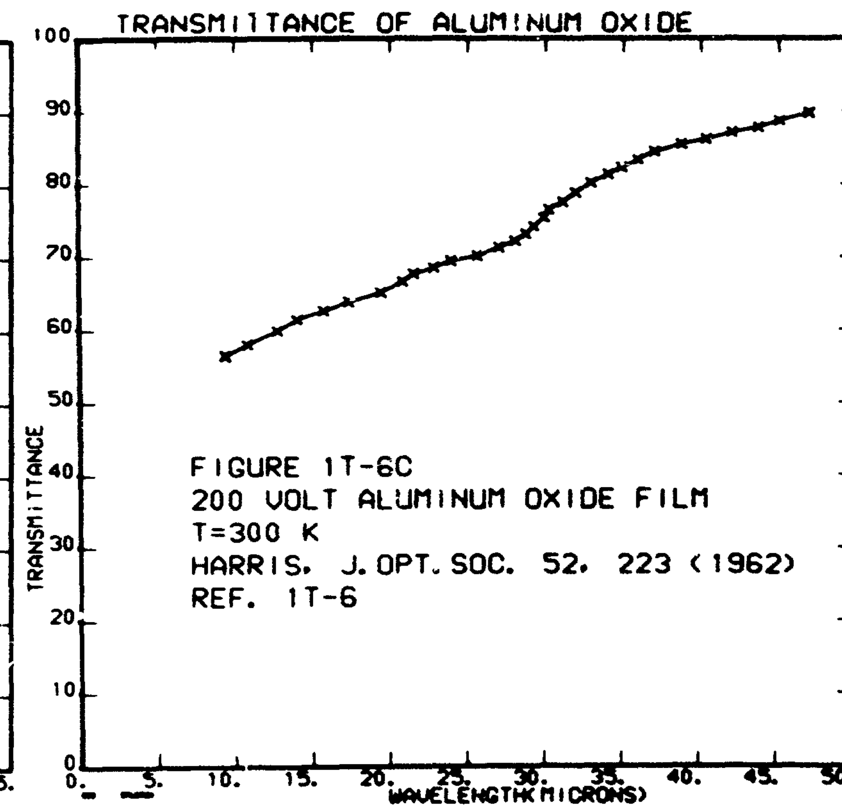

TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-6B
100 VOLT ALUMINUM OXIDE FILM
T=300 K
HARRIS. J. OPT. SOC. 52. 223 (1962)
REF. 1T-6
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0 10 20 30 40 50 60 70 80 90 100

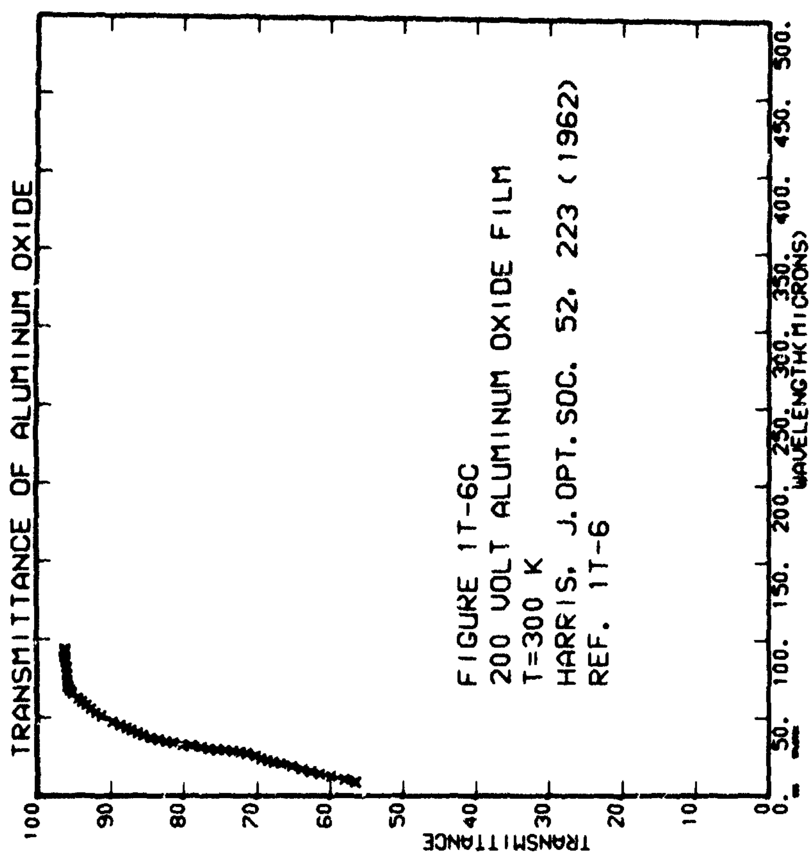
Harris (Ref. 1T-6)

c. 200 volt film

λ	T	λ	T	λ	T	λ	T
9.355	5.653E+01	16.614	5.301E+01	12.762	5.994E+01	14.004	6.158E+01
15.695	5.275E+01	17.362	6.395E+01	19.400	5.528E+01	20.844	6.578E+01
21.525	6.755E+01	22.615	6.305E+01	23.900	6.950E+01	25.610	7.024E+01
27.624	7.136E+01	28.373	7.227E+01	26.791	7.329E+01	29.259	7.434E+01
29.920	7.554E+01	30.234	7.059E+01	31.158	7.761E+01	31.975	7.896E+01
32.945	8.025E+01	34.403	6.141E+01	34.911	8.240E+01	35.993	8.347E+01
37.642	8.452E+01	38.701	8.553E+01	40.359	8.625E+01	42.005	8.710E+01
43.763	8.735E+01	45.607	8.377E+01	46.976	8.985E+01	53.963	9.134E+01
53.213	9.210E+01	55.451	9.273E+01	58.123	9.335E+01	59.976	9.393E+01
62.241	9.445E+01	62.571	9.527E+01	67.748	9.560E+01	76.165	9.580E+01
73.493	9.537E+01	77.592	9.564E+01	82.069	9.603E+01	85.047	9.520E+01
88.7[illegible]	9.525E+01	92.162	9.626E+01	93.932	9.627E+01		


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-6C
200 VOLT ALUMINUM OXIDE FILM
T=300 K
HARRIS. J. OPT. SOC. 52, 223 (1962)
REF. 1T-6
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-6C
200 VOLT ALUMINUM OXIDE FILM
T=300 K
HARRIS. J. OPT. SOC. 52, 223 (1962)
REF. 1T-6
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 5. 10. 15. 20. 25. 30. 35. 40. 45. 50.



TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-6C
200 VOLT ALUMINUM OXIDE FILM
T=300 K
HARRIS, J.OPT.SOC. 52, 223 (1962)
REF. 1T-6
TRANSMITTANCE
WAVELENGTH(MICRONS)

Lee (Ref. 1T-8)

Sapphire samples 2 mm thick were examined using a Beckman IR-3 spectrophotometer having an unspecified bandpass, over a temperature range of 297°K to 1473°K. No error analysis was given. Data were digitized from curves.

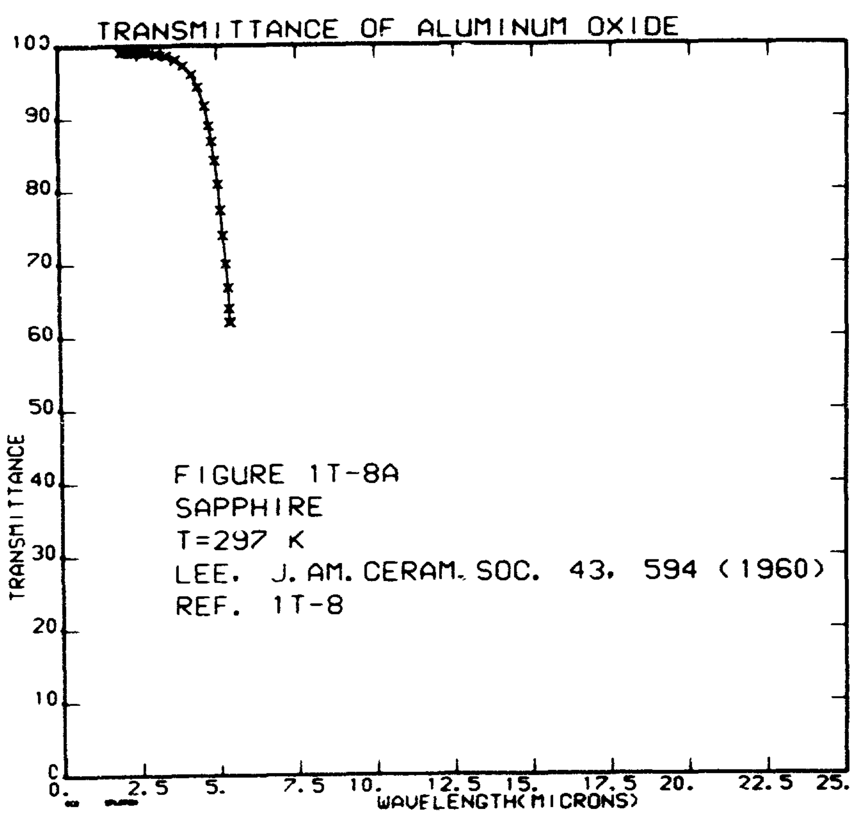
These data are in general agreement with the representative curve given in Section I - 1.6.

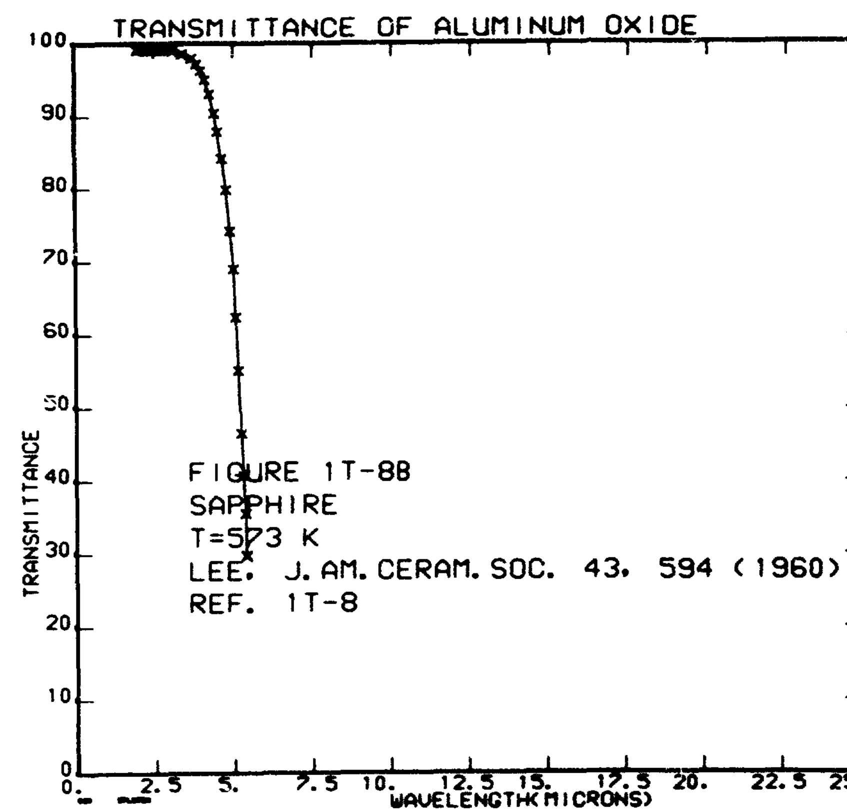
a. T = 297°K

λ	T	λ	T	λ	T	λ	T
2.000	9.921E+01	2.155	9.921E+01	2.329	9.921E+01	2.494	9.921E+01
2.674	9.921E+01	2.867	9.921E+01	3.103	9.899E+01	3.441	9.872E+01
3.718	9.814E+01	3.950	9.731E+01	4.215	9.613E+01	4.421	9.431E+01
4.626	9.169E+01	4.754	8.904E+01	4.850	8.689E+01	4.934	8.420E+01
5.026	8.101E+01	5.119	7.748E+01	5.196	7.401E+01	5.271	7.012E+01
5.326	6.686E+01	5.365	6.406E+01	5.386	6.213E+01		

b. T = 573°K

λ	T	λ	T	λ	T	λ	T
2.000	9.921E+01	2.179	9.921E+01	2.364	9.921E+01	2.512	9.921E+01
2.701	9.921E+01	2.852	9.920E+01	3.100	9.900E+01	3.422	9.867E+01
3.698	9.803E+01	3.859	9.728E+01	3.981	9.630E+01	4.104	9.508E+01
4.253	9.309E+01	4.400	9.044E+01	4.514	8.789E+01	4.639	8.415E+01
4.768	7.973E+01	4.892	7.424E+01	4.981	6.909E+01	5.067	6.240E+01
5.145	5.516E+01	5.237	4.655E+01	5.298	4.072E+01	5.358	3.551E+01
5.411	2.974E+01						


TRANSMITTANCE OF ALUMINUM OXIDE
TRANSMITTANCE
100
90
80
70
60
50
40
30
20
10
0
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)
FIGURE 1T-8A
SAPPHIRE
T=297 K
LEE. J. AM. CERAM. SOC. 43, 594 (1960)
REF. 1T-8


TRANSMITTANCE OF ALUMINUM OXIDE
TRANSMITTANCE
100
90
80
70
60
50
40
30
20
10
0
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
WAVELENGTH(MICRONS)
FIGURE 1T-8B
SAPPHIRE
T=573 K
LEE. J. AM. CERAM. SOC. 43, 594 (1960)
REF. 1T-8

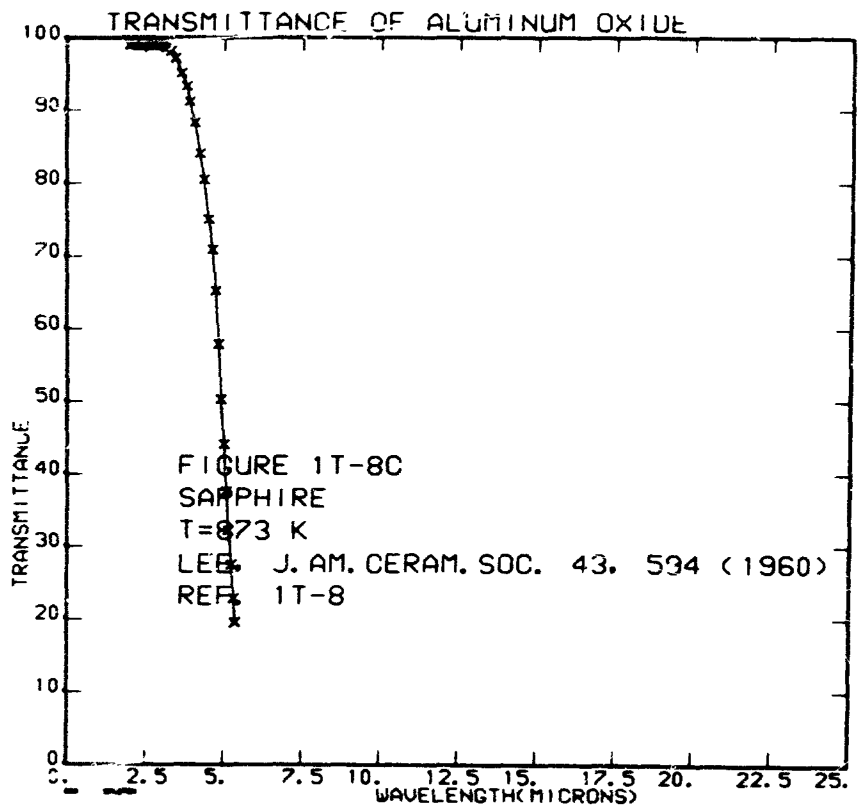
Lee (Ref. 1T-8)

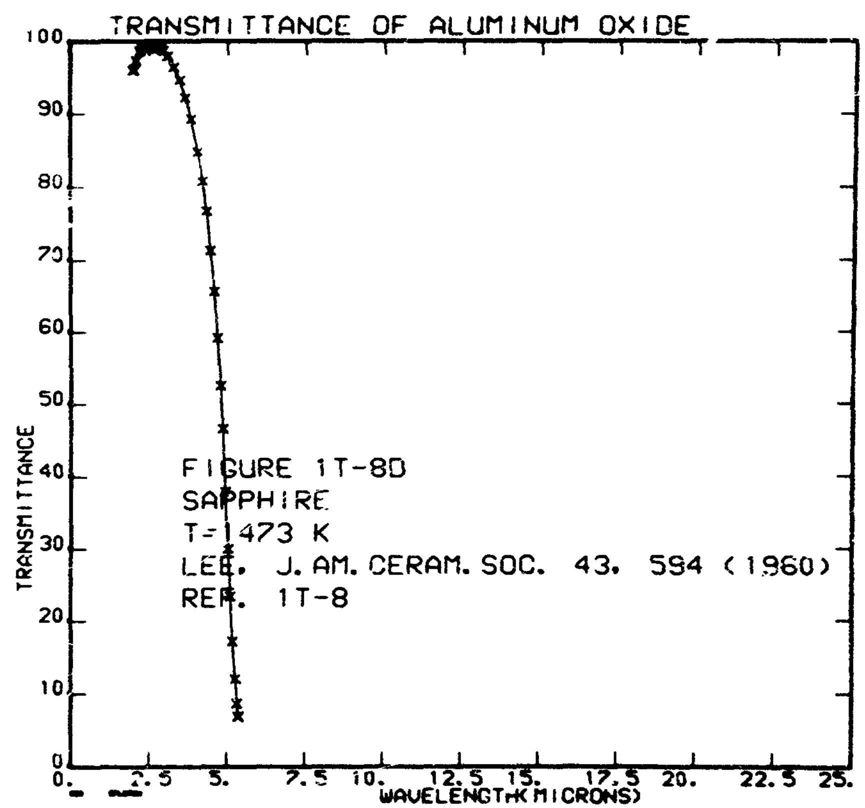
c. $T = 873^{o}K$

λ	T	λ	T	λ	T	λ	T
2.000	9.909E+01	2.190	9.909E+01	2.347	9.909E+01	2.511	9.909E+01
2.708	9.909E+01	2.864	9.909E+01	3.041	9.909E+01	3.166	9.876E+01
3.308	9.829E+01	3.458	9.722E+01	3.646	9.524E+01	3.802	9.343E+01
3.920	9.128E+01	4.072	8.838E+01	4.238	8.417E+01	4.371	8.049E+01
4.518	7.519E+01	4.627	7.095E+01	4.731	6.530E+01	4.834	5.798E+01
4.921	5.030E+01	5.000	4.414E+01	5.091	3.760E+01	5.170	3.220E+01
5.255	2.757E+01	5.331	2.281E+01	5.394	1.950E+01		

d. $T = 1473^{o}K$

λ	T	λ	T	λ	T	λ	T
2.000	9.616E+01	2.096	9.741E+01	2.203	9.872E+01	2.280	9.924E+01
2.453	9.924E+01	2.620	9.924E+01	2.763	9.910E+01	2.891	9.906E+01
2.970	9.876E+01	3.077	9.805E+01	3.296	9.659E+01	3.482	9.470E+01
3.656	9.221E+01	3.833	8.930E+01	4.050	8.487E+01	4.217	8.084E+01
4.346	7.677E+01	4.456	7.139E+01	4.573	6.566E+01	4.693	5.923E+01
4.782	5.267E+01	4.862	4.660E+01	4.940	3.791E+01	5.027	3.007E+01
5.107	2.339E+01	5.191	1.724E+01	5.275	1.208E+01	5.347	8.743E+00
5.393	6.928E+00						


TRANSMITTANCE OF ALUMINUM OXIDE
TRANSMITTANCE
WAVELENGTH(MICRONS)
FIGURE 1T-8C
SAPPHIRE
T=873 K
LEE. J. AM. CERAM. SOC. 43. 594 (1960)
REF. 1T-8


TRANSMITTANCE OF ALUMINUM OXIDE
TRANSMITTANCE
WAVELENGTH(MICRONS)
FIGURE 1T-8D
SAPPHIRE
T=1473 K
LEE. J. AM. CERAM. SOC. 43. 594 (1960)
REF. 1T-8

Loewenstein (Ref. 1T-9)

The transmissivity of synthetic sapphire was measured in the far infrared using an interferometer. No experimental details or error analyses were given. The data were digitized from points.

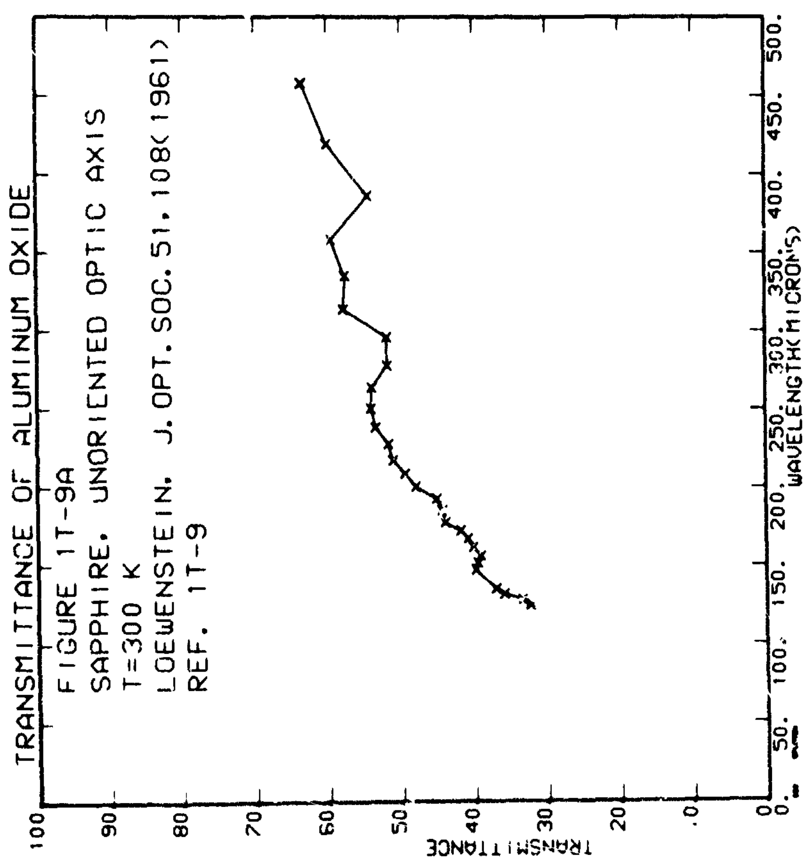
These data are in good general agreement with the representative curve given in Section I - 1.6.

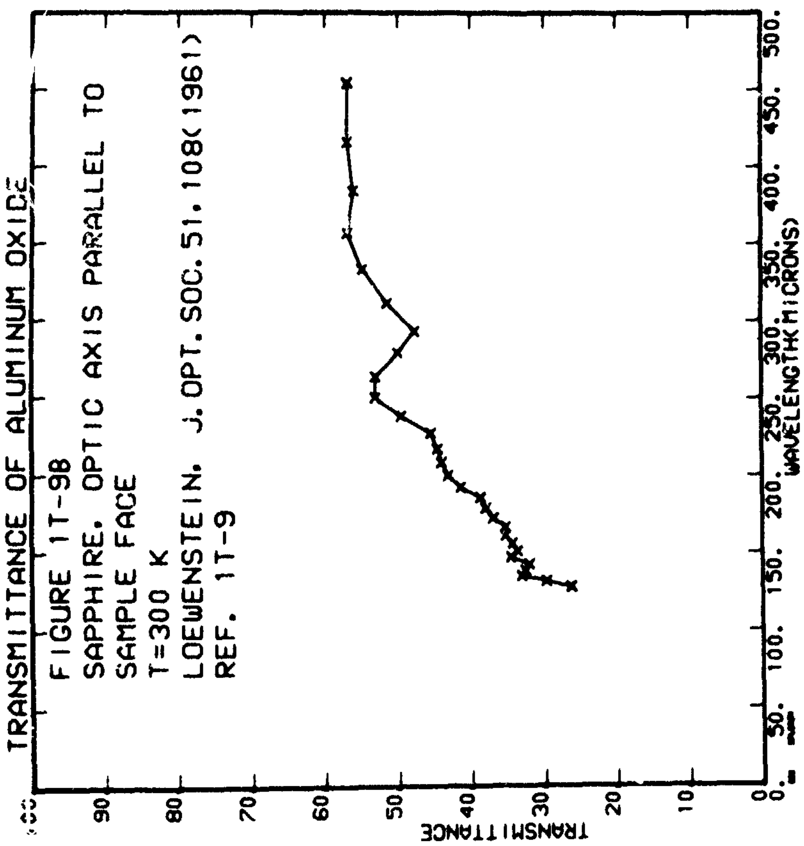
a. Optic axis unoriented

λ	T	λ	T	λ	T
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.459E+01
[illegible]	[illegible]	[illegible]	[illegible]	3.136E+02	5.789E+01
[illegible]	[illegible]	[illegible]	[illegible]	2.635E+02	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.172E+01
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.803E+01
[illegible]	[illegible]	[illegible]	[illegible]	1.773E+02	4.405E+01
[illegible]	[illegible]	1.573E+02	[illegible]	1.510E+02	4.024E+01
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.998E+01
[illegible]	[illegible]	1.318E+02	[illegible]	1.283E+02	3.351E+01
[illegible]	[illegible]				

b. Optic axis parallel to face of sapphire sample

λ	T	λ	T	λ	T
9.729E+02	5.207E+01	8.279E+02	5.065E+01	7.126E+02	4.555E+01
6.223E+02	4.449E+01	5.569E+02	4.606E+01	5.023E+02	4.767E+01
4.549E+02	5.700E+01	4.162E+02	5.700E+01	3.847E+02	5.617E+01
3.574E+02	5.705E+01	3.337E+02	5.490E+01	3.117E+02	5.150E+01
2.933E+02	4.771E+01	2.790E+02	5.005E+01	2.639E+02	5.309E+01
2.501E+02	5.312E+01	2.382E+02	4.961E+01	2.270E+02	4.553E+01
2.174E+02	4.460E+01	2.082E+02	4.414E+01	1.997E+02	4.325E+01
1.923E+02	4.149E+01	1.855E+02	3.870E+01	1.785E+02	3.801E+01
1.723E+02	3.699E+01	1.666E+02	3.537E+01	1.611E+02	3.533E+01
1.561E+02	3.439E+01	1.514E+02	3.369E+01	1.472E+02	3.460E+01
1.427E+02	3.202E+01	1.387E+02	3.253E+01	1.351E+02	3.299E+01
1.318E+02	2.973E+01	1.284E+02	2.621E+01		


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-9A
SAPPHIRE. UNORIENTED OPTIC AXIS
T=300 K
LOEWENSTEIN. J.OPT.SOC.51.108(1961)
REF. 1T-9
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0 10 20 30 40 50 60 70 80 90 100

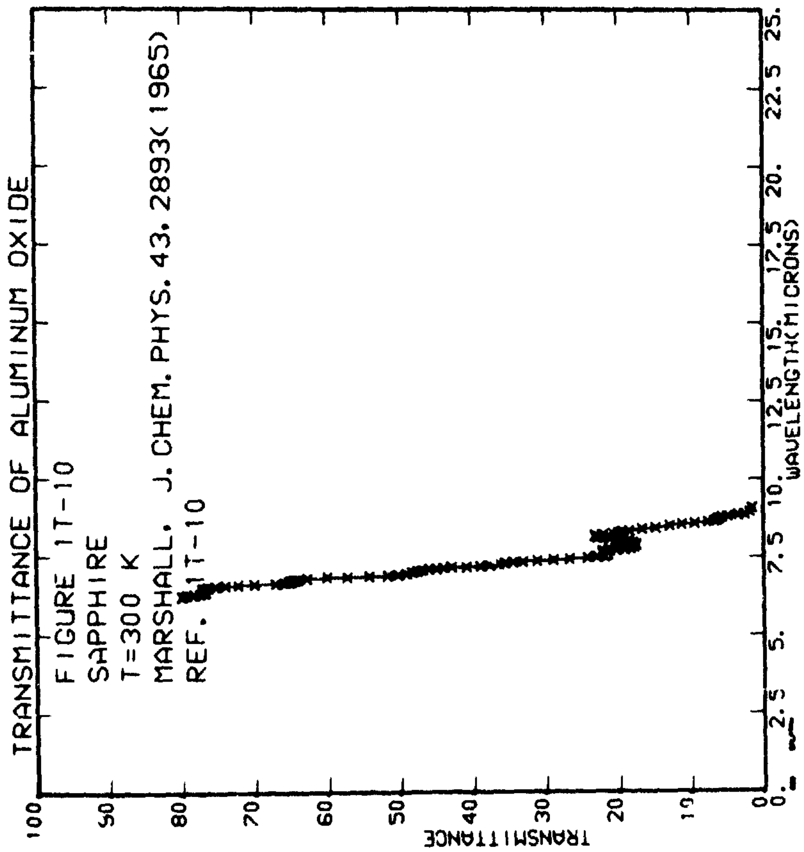

TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-9B
SAPPHIRE. OPTIC AXIS PARALLEL TO
SAMPLE FACE
T=300 K
LOEWENSTEIN. J.OPT.SOC.51.108(1961)
REF. 1T-9
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0 10 20 30 40 50 60 70 80 90

Marshall (Ref. 1T-10)

The transmissivity of sapphire from 6μ to 10μ was measured using unspecified methods. Sample thickness was approximately 150μ. No error analysis was given. Data were digitized from curves.

These data are in good general agreement with the representative curve given in Section I - 1.6.

λ	T	λ	T	λ	T
9.086	1.570E+00	8.962	1.581E+00	8.865	2.558E+00
8.849	3.405E+00	8.867	4.893E+00	8.777	5.693E+00
8.738	6.130E+00	8.686	6.485E+00	8.652	6.840E+00
8.624	7.673E+00	8.597	9.439E+00	8.554	1.119E+01
8.500	1.296E+01	8.445	1.479E+01	8.400	1.666E+01
8.344	1.843E+01	8.304	1.944E+01	8.276	1.959E+01
8.253	2.004E+01	8.228	2.084E+01	8.206	2.219E+01
8.182	2.299E+01	8.155	2.321E+01	8.135	2.285E+01
8.095	2.127E+01	8.053	1.981E+01	8.006	1.851E+01
7.959	1.791E+01	7.911	1.743E+01	7.874	1.748E+01
7.830	1.780E+01	7.790	1.837E+01	7.762	1.913E+01
7.737	2.046E+01	7.717	2.138E+01	7.693	2.204E+01
7.669	2.216E+01	7.638	2.197E+01	7.597	2.165E+01
7.567	2.155E+01	7.544	2.169E+01	7.513	2.295E+01
7.434	2.422E+01	7.444	2.675E+01	7.417	2.895E+01
7.391	3.113E+01	7.362	3.314E+01	7.339	3.455E+01
7.338	3.559E+01	7.275	3.642E+01	7.241	3.776E+01
7.214	3.901E+01	7.190	4.098E+01	7.174	4.295E+01
7.158	4.406E+01	7.137	4.502E+01	7.113	4.618E+01
7.085	4.706E+01	7.051	4.775E+01	7.010	4.842E+01
6.972	4.320E+01	6.938	5.032E+01	6.913	5.176E+01
6.889	5.438E+01	6.871	5.731E+01	6.855	6.014E+01
6.820	6.293E+01	6.791	6.411E+01	6.761	6.465E+01
6.729	6.500E+01	6.700	6.538E+01	6.684	6.593E+01
6.669	6.721E+01	6.642	7.019E+01	6.621	7.234E+01
6.592	7.410E+01	6.560	7.554E+01	6.528	7.657E+01
6.498	7.719E+01	6.470	7.733E+01	6.445	7.717E+01
6.417	7.697E+01	6.364	7.697E+01	6.366	7.702E+01
6.343	7.762E+01	6.322	7.841E+01	6.295	7.948E+01
6.272	8.000E+01	6.249	8.000E+01		


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-10
SAPPHIRE
T=300 K
MARSHALL, J. CHEM. PHYS. 43, 2893(1965)
REF. 1T-10
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

McAlister (Ref. 1T-11)

The transmittance of sapphire from 1μ to 6μ at temperatures of 673°K, 873°K, and 1073°K was measured using a Perkin-Elmer 112 spectrometer with NaCl optics. The precision of the transmittance data is estimated to be ± 1 percent. Data were digitized from curves.

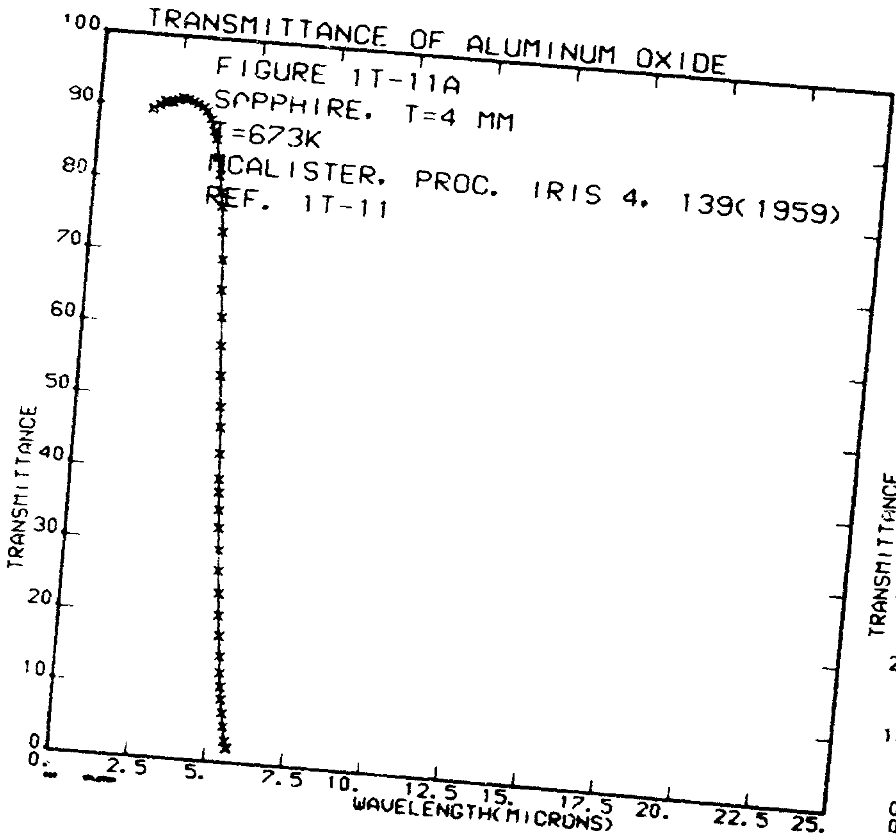
These data are in good general agreement with the representative curve given in Section I - 1.6.

a) T = 673°K

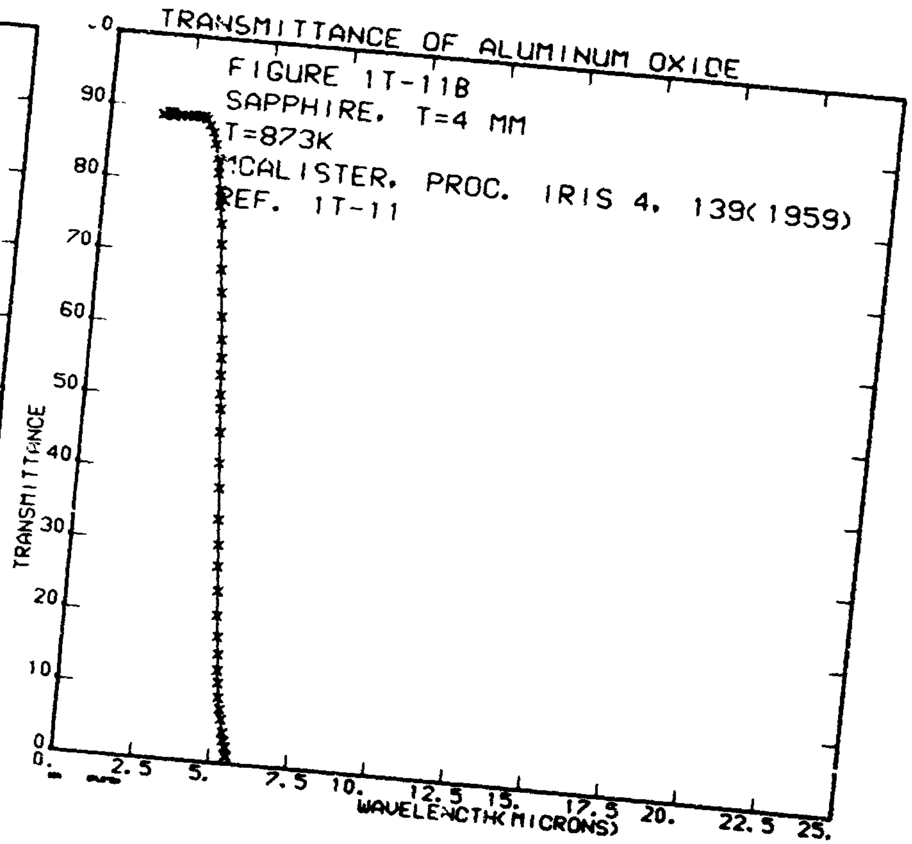
λ	T	λ	T	λ	T	λ	T
1.715	8.965E+01	1.938	9.024E+01	2.052	9.079E+01	2.170	9.067E+01
2.319	9.077E+01	2.465	9.113E+01	2.613	9.145E+01	2.795	9.130E+01
2.959	9.105E+01	3.119	9.074E+01	3.281	9.031E+01	3.410	8.984E+01
3.552	8.870E+01	3.682	8.711E+01	3.783	8.610E+01	3.882	8.356E+01
3.979	8.114E+01	4.056	7.886E+01	4.126	7.580E+01	4.211	7.336E+01
4.290	6.944E+01	4.347	6.530E+01	4.418	6.156E+01	4.468	5.757E+01
4.546	5.341E+01	4.612	4.913E+01	4.664	4.630E+01	4.708	4.262E+01
4.748	3.911E+01	4.777	3.729E+01	4.832	3.486E+01	4.879	3.229E+01
4.936	2.935E+01	4.986	2.641E+01	5.050	2.338E+01	5.110	2.026E+01
5.181	1.739E+01	5.250	1.451E+01	5.319	1.222E+01	5.371	1.034E+01
5.406	8.616E+00	5.487	6.722E+00	5.562	4.815E+00	5.643	2.868E+00
5.708	1.907E+00						

b) T = 873°K

λ	T	λ	T	λ	T	λ	T
3.158	8.695E+01	3.261	8.513E+01	3.358	8.337E+01	3.437	8.172E+01
3.521	7.926E+01	3.581	7.660E+01	3.651	7.438E+01	3.726	7.120E+01
3.799	6.826E+01	3.862	6.547E+01	3.932	6.269E+01	3.991	5.971E+01
4.059	5.531E+01	4.130	5.299E+01	4.189	5.041E+01	4.245	4.692E+01
4.293	4.400E+01	4.359	4.132E+01	4.416	3.810E+01	4.499	3.419E+01
4.570	3.064E+01	4.645	2.741E+01	4.694	2.497E+01	4.744	2.185E+01
4.793	1.973E+01	4.855	1.569E+01	4.916	1.331E+01	4.981	1.131E+01
5.025	8.999E+00	5.095	7.103E+00	5.187	4.946E+00	5.288	3.381E+00



TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-11A
SAPPHIRE. T=4 MM
T=673K
MCALISTER. PROC. IRIS 4. 139(1959)
REF. 1T-11
TRANSMITTANCE
WAVELENGTH(MICRONS)

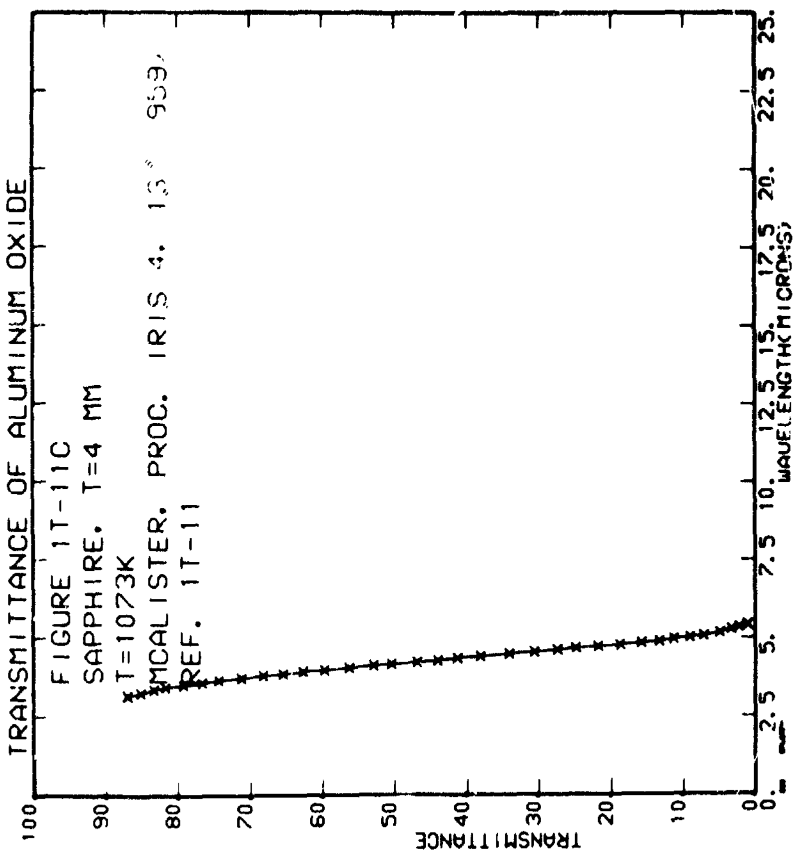


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-11B
SAPPHIRE. T=4 MM
T=873K
MCALISTER. PROC. IRIS 4. 139(1959)
REF. 1T-11
TRANSMITTANCE
WAVELENGTH(MICRONS)

McAlister (Ref. 1T-11)

c) T = 1073°K

λ	T	λ	T	λ	T	λ	T
1.595	8.891E+01	1.852	8.933E+01	1.957	8.938E+01	2.044	8.888E+01
2.242	8.907E+01	2.435	8.903E+01	2.634	8.904E+01	2.514	8.919E+01
2.967	8.912E+01	3.061	8.885E+01	3.196	8.804E+01	3.302	8.700E+01
3.407	8.545E+01	3.516	8.344E+01	3.597	8.143E+01	3.678	7.916E+01
3.745	7.693E+01	3.824	7.452E+01	3.897	7.160E+01	3.968	6.826E+01
4.042	6.505E+01	4.104	6.176E+01	4.175	5.852E+01	4.230	5.589E+01
4.264	5.363E+01	4.318	5.791E+01	4.365	4.895E+01	4.422	4.571E+01
4.494	4.146E+01	4.569	3.876E+01	4.647	3.364E+01	4.709	3.014E+01
4.755	2.713E+01	4.823	2.370E+01	4.893	2.036E+01	4.965	1.739E+01
5.028	1.498E+01	5.071	1.277E+01	5.114	1.105E+01	5.161	8.998E+00
5.229	7.472E+00	5.303	6.025E+00	5.384	4.223E+00	5.443	3.091E+00
5.498	2.315E+00	5.571	1.026E+00				



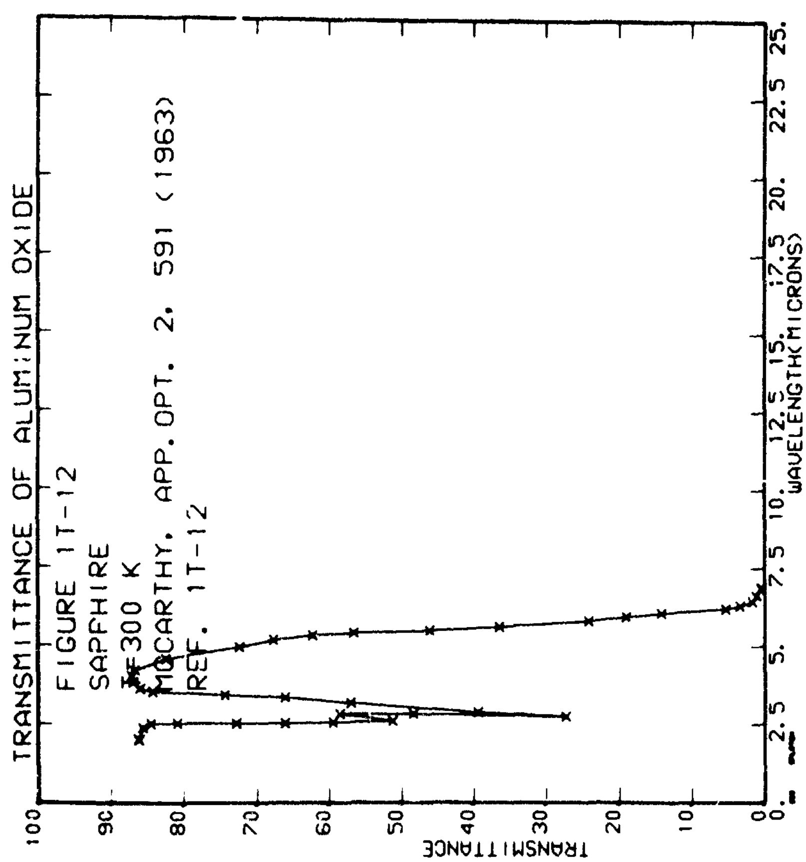
TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-11C
SAPPHIRE. T=4 MM
T=1073K
MCALISTER. PROC. IRIS 4.
REF. 1T-11
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

McCarthy (Ref. 1T-12)

A Beckman IR-5A spectrometer in the 2μ to 6μ region and a Beckman IR-7 with Cs I optics in the 12.5μ to 50μ region were used to measure the transmittance of 2 mm thick synthetic sapphire. No bandpass or error information was given. The sample temperature is unspecified and may be assumed to be approximately 300°K. These data were digitized from a curve.

These data are in good agreement with the representative curve given in Section I - 1.6. except for the strong 2.5μ to 4.0μ band attributable to water.

λ	T	λ	T	λ	T	λ	T
[illegible]	3.511E+01	2.362	[illegible].[illegible]69E+01	2.503	8.456E+01	2.535	8.086E+01
2.[illegible]31	[illegible].2[illegible]E+01	2.[illegible]31	5.5[illegible]4E+01	2.553	5.349E+01	2.619	5.126E+01
2.[illegible]	5.853E+01	2.[illegible]4[illegible]	4.933E+01	2.772	2.736E+01	2.873	3.949E+01
3.1[illegible]8	[illegible].767E+01	3.351	6.6[illegible]3E+01	3.424	7.436E+01	3.64[illegible]	8.434E+01
3.[illegible]5	3.[illegible]E+01	3.83[illegible]	5.692E+01	4.031	3.714E+01	4.212	8.670E+01
4.[illegible]	4.24[illegible]E+01	4.955	7.233E+01	5.193	5.765E+01	5.326	6.237E+01
5.41[illegible]	3.56[illegible]E+01	5.48[illegible]	4.513E+01	5.503	3.054E+01	5.820	2.426E+01
[illegible].935	1.30[illegible]E+01	6.069	1.423E+01	6.218	5.430E+00	6.305	3.457E+00
5.4[illegible]7	1.[illegible]91E+00	6.53[illegible]	1.157E+00	6.839	4.006E-01		

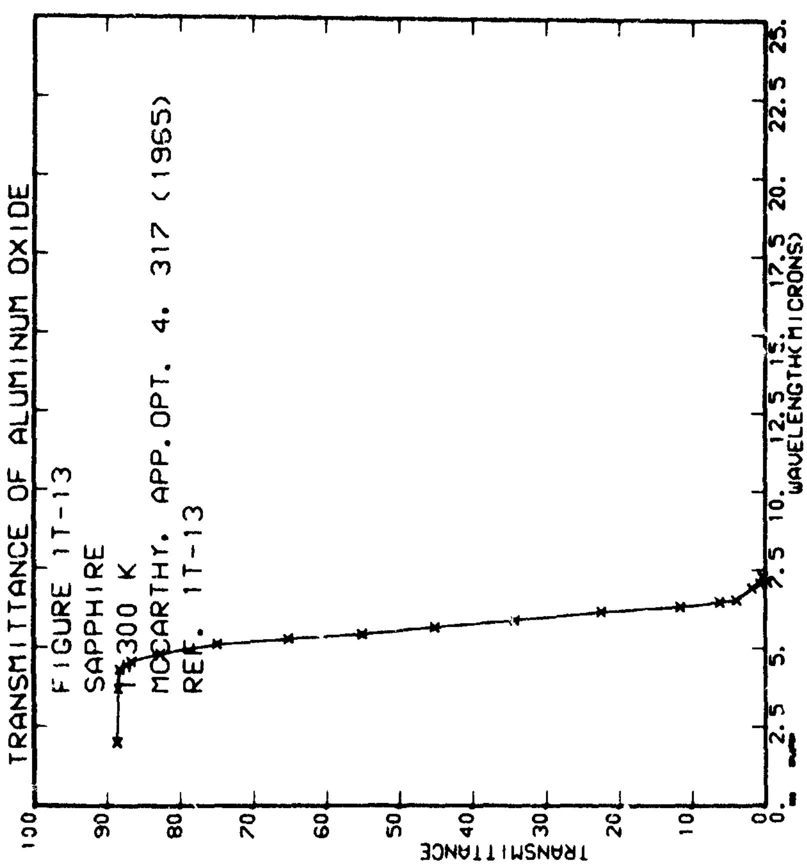

TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-12
SAPPHIRE
T=300 K
McCARTHY. APP.OPT. 2. 591 (1963)
REF. 1T-12
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0. 10 20 30 40 50 60 70 80 90 100

McCarthy (Ref. 1T-13)

Beckman 1R5-A, 1R-7, and 1R-9 spectrometers were used to measure the transmittance of 3.0 mm thick synthetic sapphire from 2μ to 50μ. All sample surfaces were flat to ten fringes or better. No bandpass or error information was given. The sample temperature is unspecified and may be assumed to be approximately 300°K. These data were digitized from a curve.

These data are in good general agreement with the representative curve given in Section I - 1.6.

λ	T	λ	T	λ	T	λ	T
2.000	8.359E+01	3.704	8.844E+01	4.304	8.823E+01	4.567	8.669E+01
4.318	8.272E+01	5.098	7.433E+01	5.290	6.522E+01	5.443	5.512E+01
5.6[illegible]5	4.514E+01	5.882	3.421E+01	6.149	2.259E+01	6.325	1.160E+01
6.482	5.260E+00	6.553	3.912E+00	6.945	1.831E+00	7.086	7.825E-01
7.204	3.130E-01						


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-13
SAPPHIRE
T=300 K
MCCARTHY, APP.OPT. 4. 317 (1965)
REF. 1T-13
TRANSMITTANCE
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
100
90
80
70
60
50
40
30
20
10
0

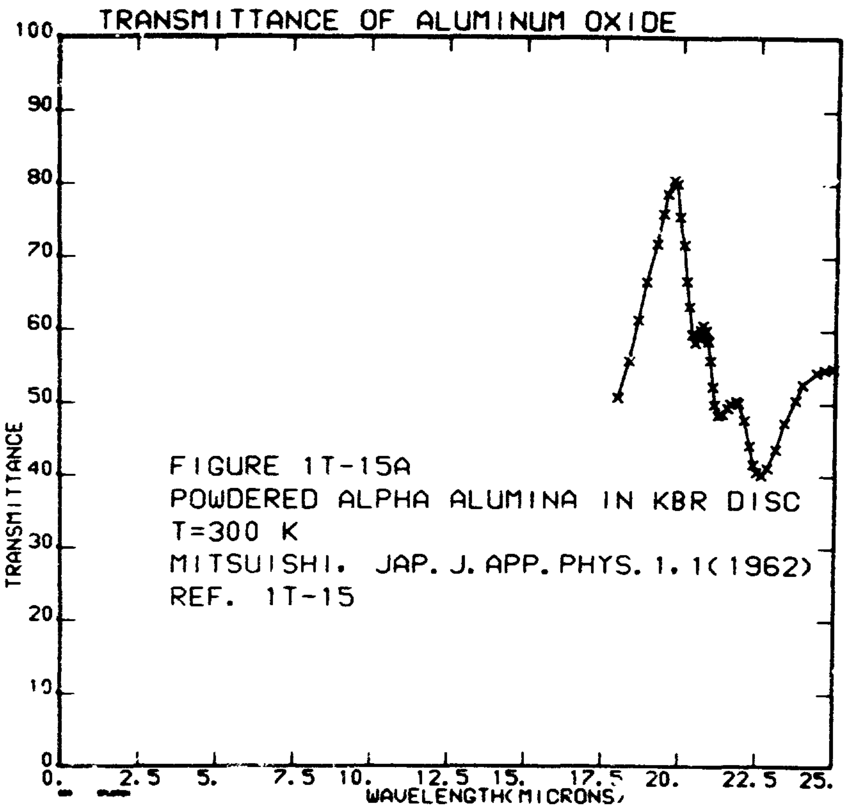
Mitsuishi (Ref. 1T-15)

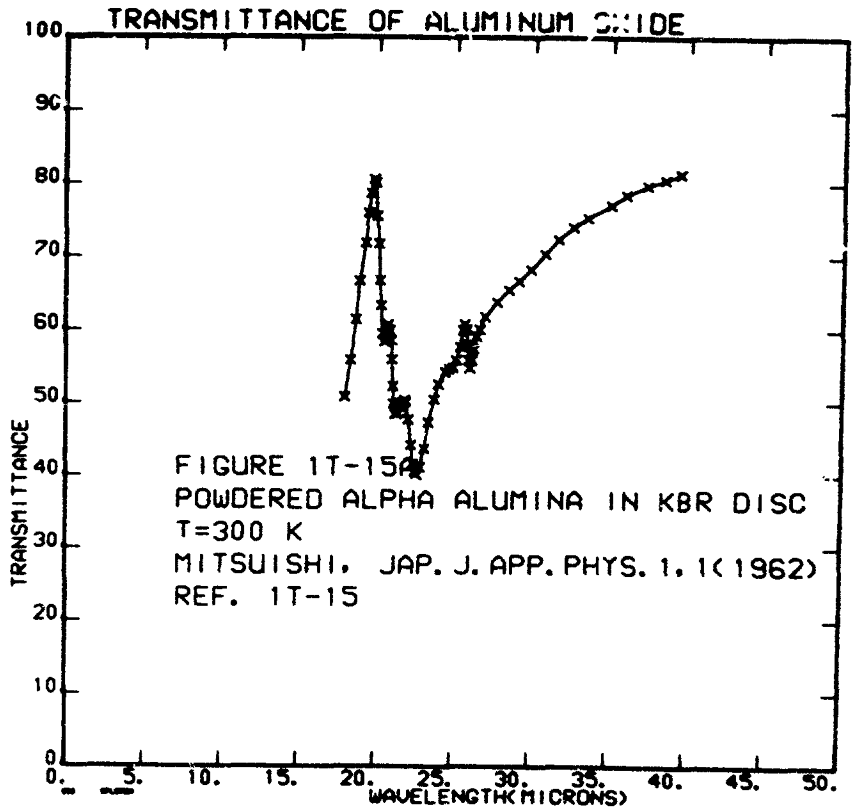
Powdered α - Al_2O_3 suspended in a KBr disk and in a polyethylene sheet was studied from 17μ to 40μ using Hitachi EPI-2 Infrared Spectrometer with unspecified bandpass. No error analysis was given. Data were digitized from curves.

These data were selected in part to construct the representative curve given in Section I - 1.6.

a) Powdered Alpha Alumina in a KBr disc

λ	T	λ	T	λ	T	λ	T
17.981	5.081E+01	18.342	5.587E+01	18.643	6.144E+01	18.879	6.672E+01
19.209	7.193E+01	19.428	7.606E+01	19.561	7.877E+01	19.767	8.064E+01
19.861	8.009E+01	19.972	7.566E+01	20.087	7.186E+01	20.191	6.682E+01
20.282	6.335E+01	20.388	5.951E+01	20.484	5.845E+01	20.615	5.917E+01
20.655	6.015E+01	20.723	6.078E+01	20.838	6.008E+01	20.914	5.867E+01
20.964	5.593E+01	21.059	5.233E+01	21.121	4.994E+01	21.224	4.845E+01
21.353	4.854E+01	21.546	4.943E+01	21.624	5.008E+01	21.805	5.040E+01
21.888	5.009E+01	22.090	4.778E+01	22.255	4.422E+01	22.394	4.169E+01
22.491	4.059E+01	22.635	4.009E+01	22.832	4.112E+01	23.103	4.379E+01
23.392	4.737E+01	23.735	5.049E+01	23.954	5.269E+01	24.393	5.426E+01
24.652	5.466E+01	24.931	5.487E+01	25.131	5.587E+01	25.375	5.777E+01
25.565	6.032E+01	25.649	6.083E+01	25.792	6.009E+01	25.845	5.807E+01
25.944	5.530E+01	26.039	5.475E+01	26.142	5.581E+01	26.242	5.741E+01
26.415	5.922E+01	26.604	6.015E+01	26.979	6.182E+01	27.718	6.383E+01
28.462	6.551E+01	29.106	6.676E+01	29.850	6.831E+01	30.768	7.047E+01
31.595	7.242E+01	32.548	7.419E+01	33.505	7.540E+01	35.001	7.710E+01
35.993	7.850E+01	37.308	7.987E+01	38.447	8.068E+01	39.465	8.140E+01

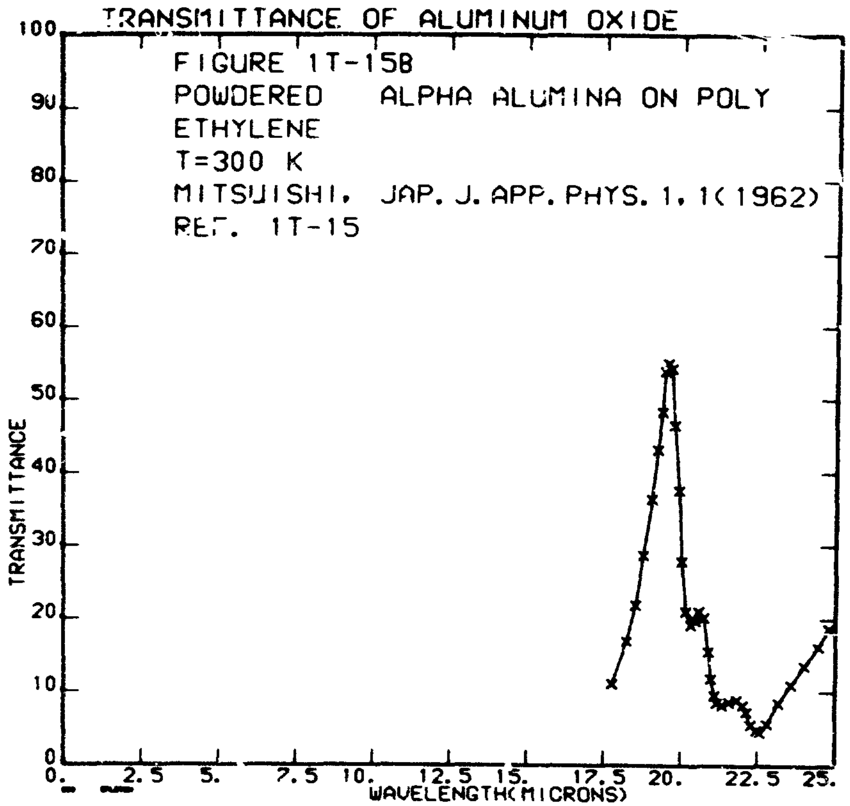

TRANSMITTANCE OF ALUMINUM OXIDE
TRANSMITTANCE
WAVELENGTH(MICRONS)
FIGURE 1T-15A
POWDERED ALPHA ALUMINA IN KBR DISC
T=300 K
MITSUISHI. JAP. J. APP. PHYS. 1. 1(1962)
REF. 1T-15

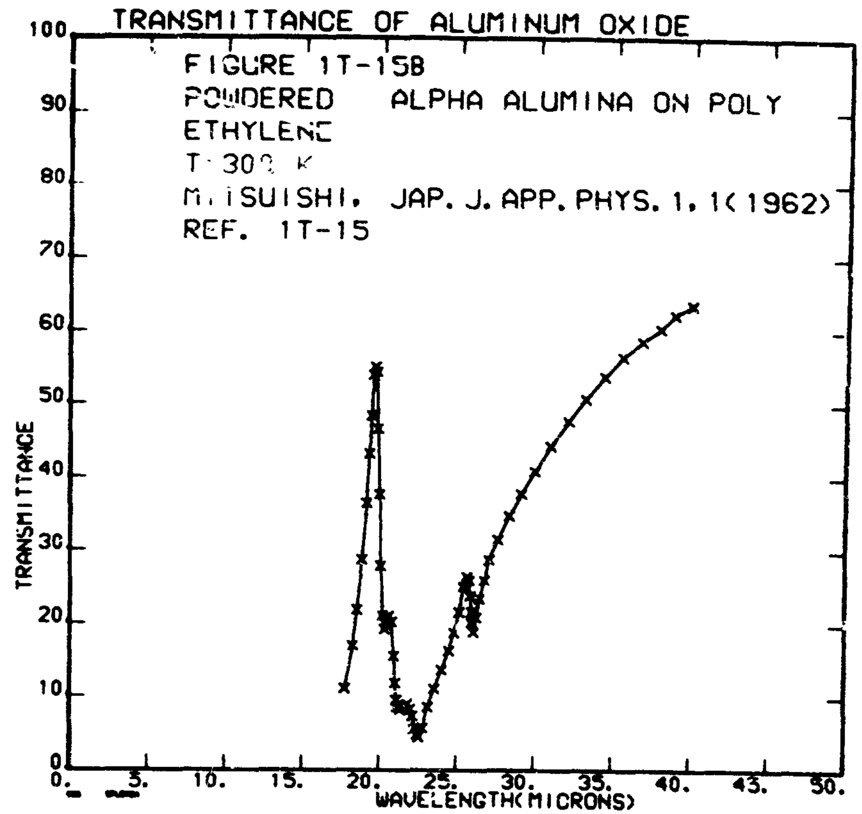

TRANSMITTANCE OF ALUMINUM OXIDE
TRANSMITTANCE
WAVELENGTH(MICRONS)
FIGURE 1T-15A
POWDERED ALPHA ALUMINA IN KBR DISC
T=300 K
MITSUISHI. JAP. J. APP. PHYS. 1. 1(1962)
REF. 1T-15

Mitsuishi (Ref. 1T-15)

b. Powdered Alpha Alumina on Polyethylene

λ	T	λ	T	λ	T	λ	T
17.778	1.108E+01	18.269	1.695E+01	18.523	2.180E+01	18.797	2.873E+01
19.055	3.642E+01	19.225	4.322E+01	19.374	4.841E+01	19.472	5.403E+01
19.558	5.519E+01	19.674	5.439E+01	19.788	4.663E+01	19.934	3.767E+01
20.042	2.792E+01	20.160	2.108E+01	20.332	1.924E+01	20.480	1.970E+01
20.587	2.102E+01	20.748	2.025E+01	20.966	1.549E+01	20.997	1.186E+01
21.119	9.527E+00	21.183	8.523E+00	21.356	8.239E+00	21.594	8.655E+00
21.842	6.920E+00	22.032	8.258E+00	22.170	7.311E+00	22.278	5.511E+00
22.448	4.716E+00	22.581	4.451E+00	22.816	5.625E+00	23.179	6.542E+00
23.579	1.104E+01	24.012	1.362E+01	24.448	1.623E+01	24.806	1.873E+01
25.122	2.155E+01	25.367	2.504E+01	25.565	2.640E+01	25.743	2.595E+01
25.836	2.369E+01	25.904	2.153E+01	25.926	2.015E+01	26.048	1.883E+01
26.224	2.087E+01	26.443	2.337E+01	26.719	2.598E+01	27.035	2.869E+01
27.560	3.140E+01	28.285	3.477E+01	29.069	3.773E+01	29.922	4.035E+01
30.932	4.438E+01	32.062	4.778E+01	33.169	5.076E+01	34.382	5.388E+01
35.538	5.652E+01	36.836	5.860E+01	37.967	6.044E+01	38.857	6.229E+01
39.979	6.362E+01						


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-15B
POWDERED ALPHA ALUMINA ON POLY
ETHYLENE
T=300 K
MITSUISHI, JAP. J. APP. PHYS. 1, 1(1962)
REF. 1T-15
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

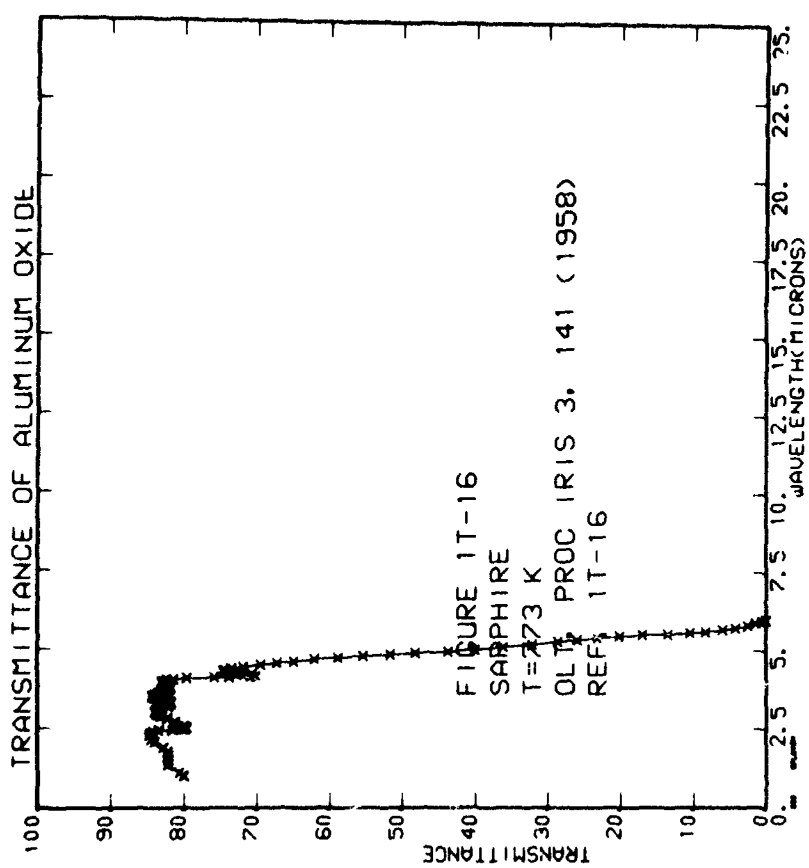

TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-15B
POWDERED ALPHA ALUMINA ON POLY
ETHYLENE
REF. 1T-15
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 5. 10. 15. 20. 25. 30. 35. 40. 43. 50.

Olt (Ref. 1T-1[?])

The transmittance of 0.125 in thick sapphire is reported from 1μ to 6μ. Experimental details are unspecified. The sample temperature is $773^{\circ}K$. The data were digitized from a curve.

These data are in good general agreement with the representative curve given in Section I - 1.6.

λ	T	λ	T	λ	T	λ	T
1.000	8.012E+01	1.108	8.075E+01	1.351	8.220E+01	1.521	8.213E+01
1.655	8.210E+01	1.789	8.224E+01	1.917	8.281E+01	2.093	8.408E+01
2.172	8.457E+01	2.289	8.486E+01	2.367	8.464E+01	2.420	8.424E+01
2.452	8.347E+01	2.466	8.154E+01	2.477	8.017E+01	2.501	7.969E+01
2.537	7.971E+01	2.592	8.005E+01	2.715	8.134E+01	2.829	8.239E+01
2.903	8.374E+01	2.964	8.376E+01	3.024	8.400E+01	3.070	8.389E+01
3.119	8.362E+01	3.173	8.303E+01	3.239	8.229E+01	3.290	8.199E+01
3.327	8.188E+01	3.368	8.224E+01	3.404	8.285E+01	3.459	8.353E+01
3.492	8.407E+01	3.527	8.439E+01	3.542	8.446E+01	3.586	8.404E+01
3.626	8.351E+01	3.667	8.288E+01	3.724	8.232E+01	3.762	8.208E+01
3.811	8.191E+01	3.861	8.213E+01	3.905	8.239E+01	3.946	8.286E+01
3.989	8.313E+01	4.020	8.293E+01	4.055	8.242E+01	4.070	8.151E+01
4.099	7.974E+01	4.124	7.593E+01	4.142	7.392E+01	4.149	7.108E+01
4.170	7.020E+01	4.198	7.073E+01	4.225	7.192E+01	4.251	7.318E+01
4.267	7.389E+01	4.293	7.444E+01	4.325	7.474E+01	4.365	7.443E+01
4.403	7.352E+01	4.459	7.191E+01	4.525	6.950E+01	4.589	6.737E+01
4.643	6.501E+01	4.698	6.215E+01	4.751	5.899E+01	4.811	5.541E+01
4.855	5.179E+01	4.904	4.823E+01	4.969	4.376E+01	5.029	4.018E+01
5.108	3.512E+01	5.197	3.221E+01	5.282	2.967E+01	5.347	2.600E+01
5.400	2.320E+01	5.450	2.018E+01	5.500	1.706E+01	5.547	1.356E+01
5.537	1.050E+01	5.621	8.350E+00	5.688	6.073E+00	5.743	4.322E+00


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-16
SAPPHIRE
T=273 K
OLT, PROC IRIS 3. 141 (1958)
REF. 1T-16
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

Oppenheim (Ref. 1T-17)

A Perkin-Elmer 12G spectrometer with unspecified bandpass was used to measure the transmittance of synthetic Meller Co. sapphire from 1μ to 6μ at temperatures ranging from $293^{o}K$ to $1273^{o}K$. The estimated accuracy of the data is 3 percent. The data were digitized from individual points.

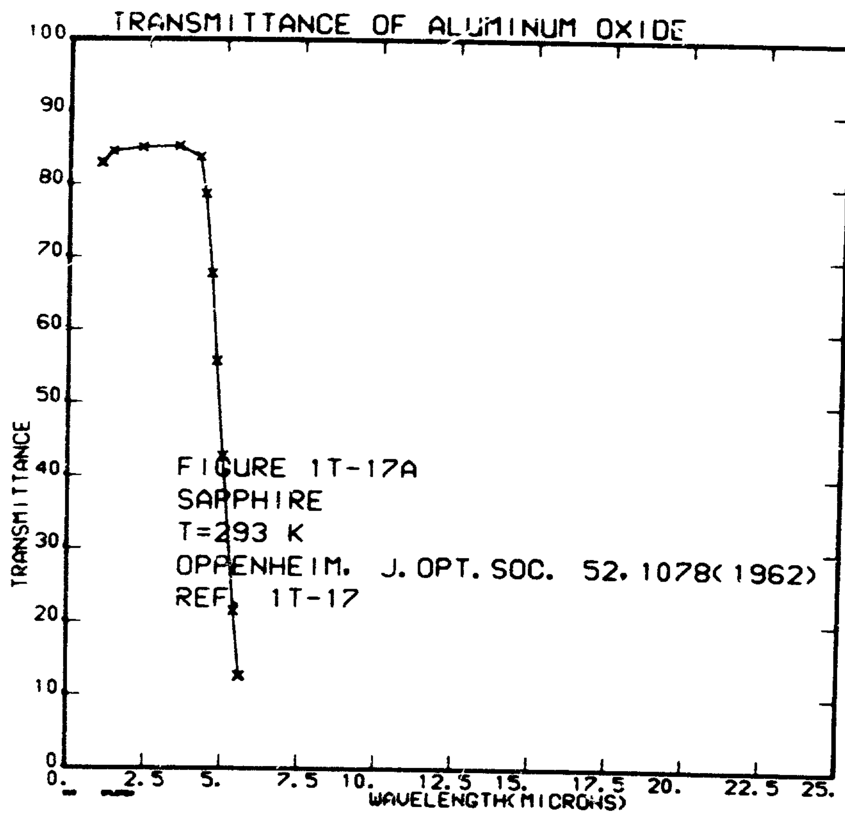
These data were selected in part to construct the representative curve given in Section I, Figure I-1.6a.

a. $T = 293^{o}K$

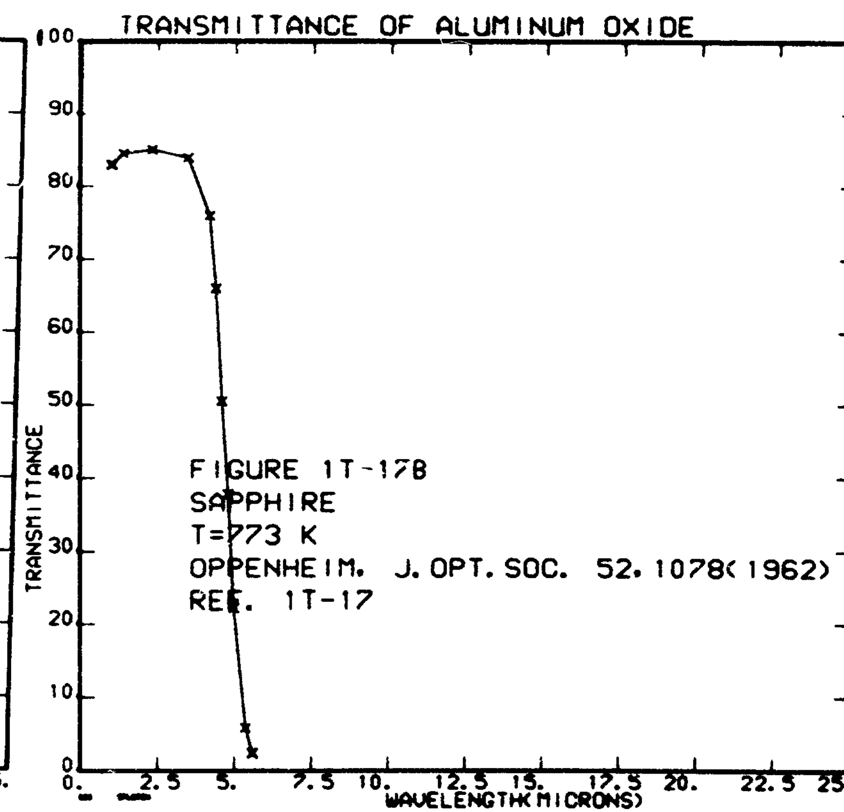
λ	T	λ	T	λ	T	λ	T
1.029	6.305E+01	1.397	8.466E+01	2.338	8.516E+01	3.213	8.538E+01
4.139	5.399E+01	4.374	7.871E+01	4.593	6.784E+01	4.792	5.579E+01
4.993	4.230E+01	5.409	2.151E+01	5.619	1.257E+01		

b.

λ	T	λ	T	λ	T	λ	T
1.025	8.301E+01	1.401	8.407E+01	2.341	8.516E+01	3.497	8.401E+01
4.190	7.533E+01	4.386	6.600E+01	4.595	5.052E+01	4.797	3.782E+01
4.992	6.227E+01	5.393	5.873E+00	5.613	2.432E+00		



TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-17A
SAPPHIRE
T=293 K
OPPENHEIM. J. OPT. SOC. 52. 1078(1962)
REF. 1T-17
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100



TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-17B
SAPPHIRE
T=773 K
OPPENHEIM. J. OPT. SOC. 52. 1078(1962)
REF. 1T-17
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.
0 10 20 30 40 50 60 70 80 90 100

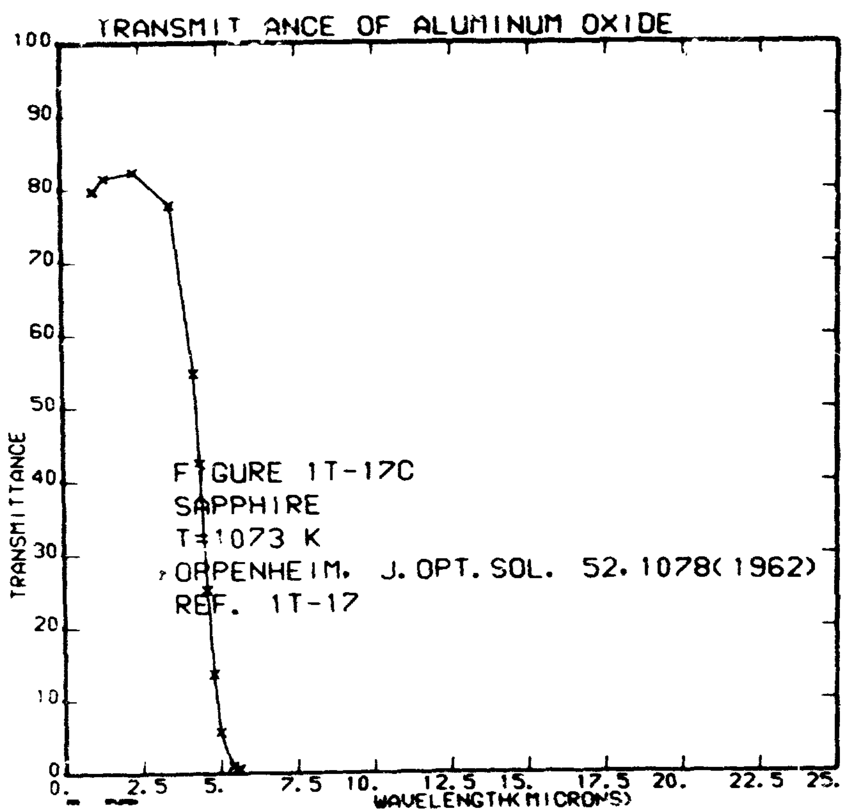
Oppenheim (Ref. 1T-17)

c. $T = 1073^{o}K$

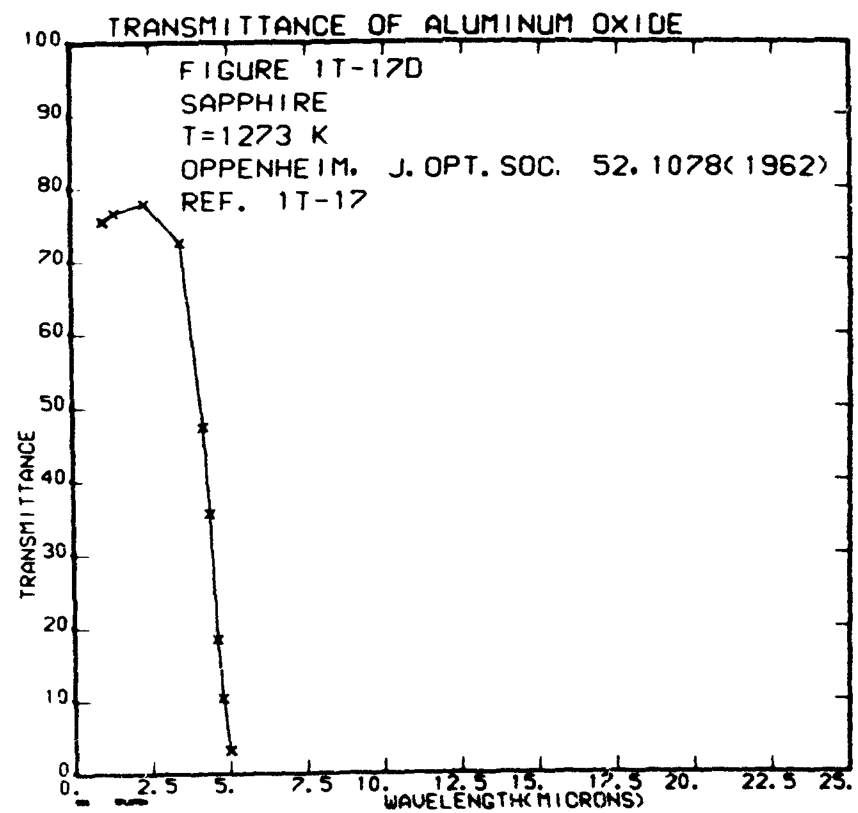
λ	T	λ	T	λ	T	λ	T
1.025	7.959E+01	1.395	6.156E+01	2.323	8.245E+01	3.491	7.788E+01
4.200	5.484E+01	4.387	4.231E+01	4.598	2.512E+01	4.799	1.561E+01
5.004	5.873E+00	5.401	1.036E+00	5.612	5.282E-01		

d. $T = 1273^{o}K$

λ	T	λ	T	λ	T	λ	T
1.027	7.341E-01	1.394	7.666E-01	2.327	7.797E-01	3.478	7.261E-01
4.159	4.729E-01	4.391	3.354E-01	4.603	1.845E-01	4.796	1.035E-01
5.003	3.288E-02						



TRANSMIT ANCE OF ALUMINUM OXIDE
FIGURE 1T-17C
SAPPHIRE
T=1073 K
OPPENHEIM. J. OPT. SOL. 52. 1078(1962)
REF. 1T-17
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.



TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-17D
SAPPHIRE
T=1273 K
OPPENHEIM. J. OPT. SOC. 52. 1078(1962)
REF. 1T-17
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Piriou (Ref 1T-19)

The infrared transmission of sapphire from 3μ to 11μ was measured at temperatures of 77°K and 273°K for sample thicknesses of 0.062 mm to 1.01 mm. The experimental details were not given. Data were digitized from curves.

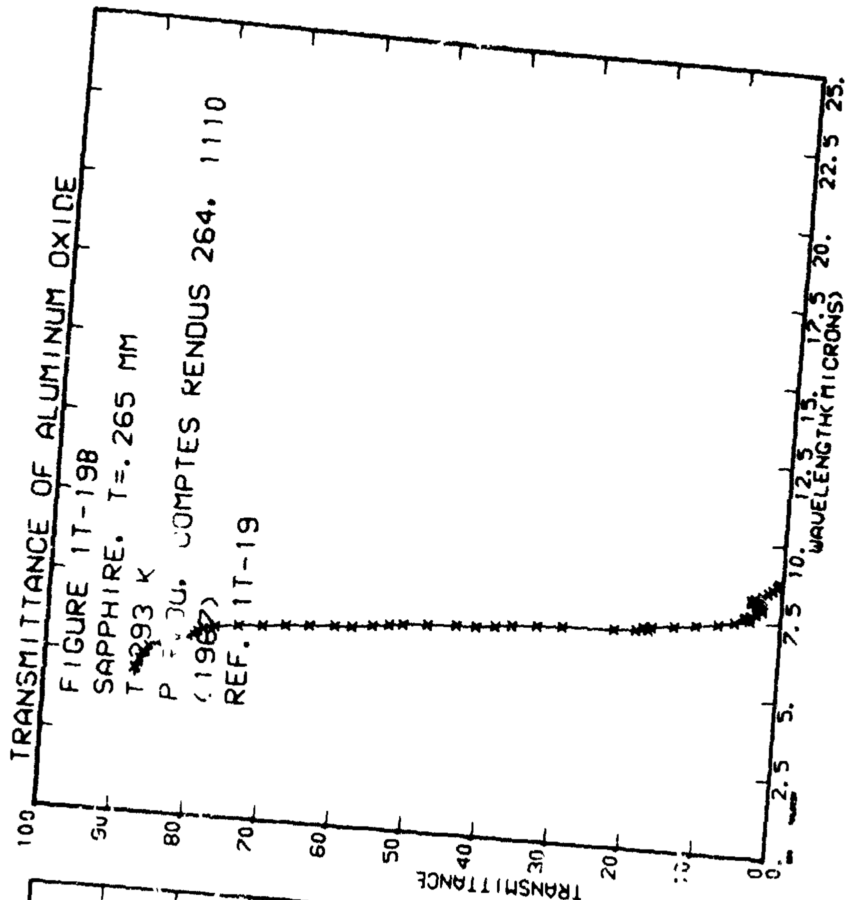
These data were selected in part to construct the representative curve given in Section I, Figure I - 1.6b.

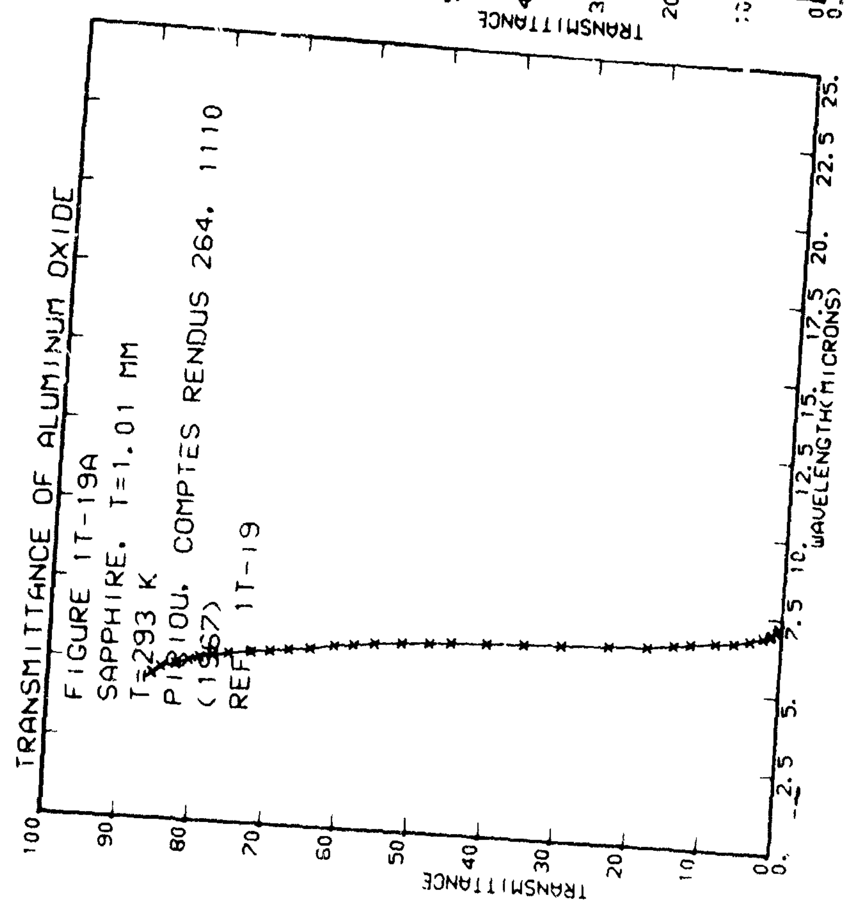
a. Thickness = 1.01 mm, T = 293°K, diamond polished, then heated for 5 hrs at 1800°K

λ	T	λ	T	λ	T	λ	T
4.579	8.598E+01	4.774	8.487E+01	4.918	8.279E+01	5.048	8.098E+01
5.149	7.959E+01	5.237	7.784E+01	5.329	7.564E+01	5.403	7.249E+01
5.477	7.003E+01	5.556	6.738E+01	5.646	6.444E+01	5.756	6.121E+01
5.845	5.856E+01	5.921	5.576E+01	5.985	5.[illegible]95E+01	6.034	4.828E+01
6.079	4.522E+01	6.124	4.038E+01	6.175	3.523E+01	6.233	3.005E+01
6.301	2.355E+01	6.362	1.828E+01	6.448	1.462E+01	6.525	1.231E+01
6.604	8.985E+00	6.653	6.473E+00	6.753	4.210E+00	6.884	2.479E+00
6.959	1.514E+00	7.007	1.331E+00	7.108	6.489E-01	7.216	4.493E-01

b. Thickness = 0.265 mm, T = 293°K, diamond polished, then heated for 5 hrs at 1800°K

λ	T	λ	T	λ	T	λ	T
4.527	8.773E+01	4.803	8.713E+01	5.013	8.681E+01	5.226	8.611E+01
5.358	8.492E+01	5.450	8.372E+01	5.552	8.207E+01	5.630	8.060E+01
5.702	8.005E+01	5.819	7.959E+01	5.922	7.888E+01	6.005	7.716E+01
6.089	7.396E+01	6.147	7.074E+01	6.210	6.746E+01	6.268	6.430E+01
6.303	6.087E+01	6.340	5.850E+01	6.402	5.573E+01	6.484	5.346E+01
6.539	5.159E+01	6.596	4.821E+01	6.633	4.426E+01	6.668	4.156E+01
6.714	3.838E+01	6.785	3.661E+01	6.832	3.314E+01	6.874	2.978E+01
6.932	2.266E+01	6.982	1.965E+01	7.016	1.795E+01	7.077	1.871E+01
7.118	1.752E+01	7.188	1.449E+01	7.265	1.149E+01	7.363	8.436E+00
7.454	6.290E+00	7.550	4.143E+00	7.604	4.692E+00	7.635	5.008E+00
7.694	4.250E+00	7.793	3.378E+00	7.900	2.662E+00	8.023	2.712E+00
8.084	3.328E+00	8.137	4.010E+00	8.203	4.110E+00	8.272	3.677E+00
8.367	2.779E+00	8.487	1.947E+00	8.580	1.314E+00	8.690	7.820E-01
8.794	5.324E-01						

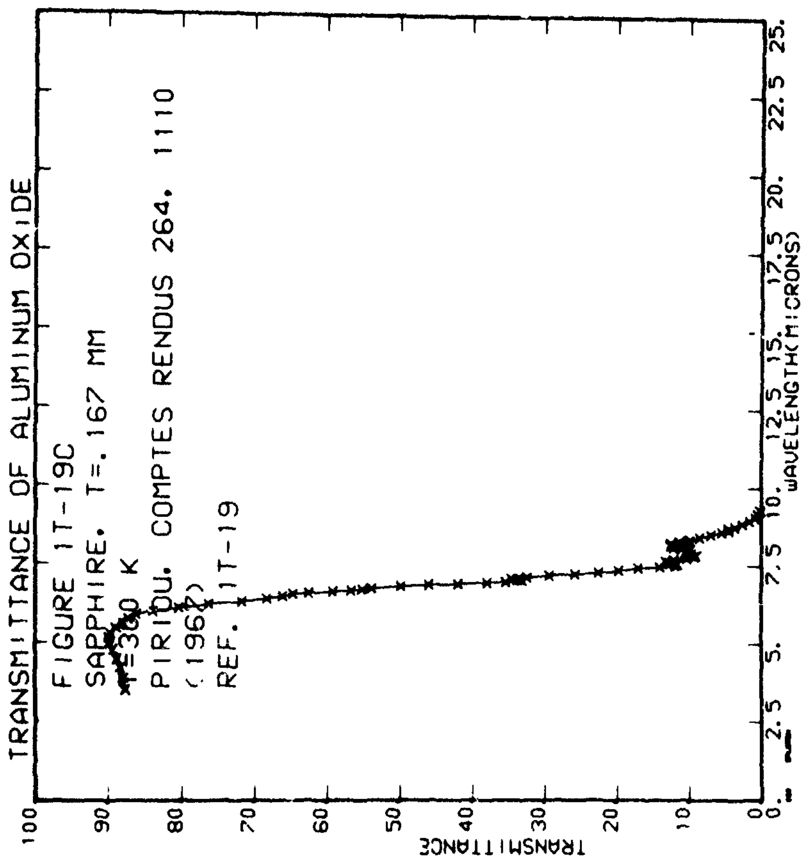

TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-19B
SAPPHIRE. T=.265 MM
T=293 K
COMPTES RENDUS 264. 1110
(1967)
REF. 1T-19
TRANSMITTANCE
WAVELENGTH(MICRONS)


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-19A
SAPPHIRE. T=1.01 MM
T=293 K
PIRIOU. COMPTES RENDUS 264. 1110
(1967)
REF. 1T-19
TRANSMITTANCE
WAVELENGTH(MICRONS)

Piriou (Ref. 1T-19)

c. Thickness = 0.167 mm, T = 300°K, chemically etched surface

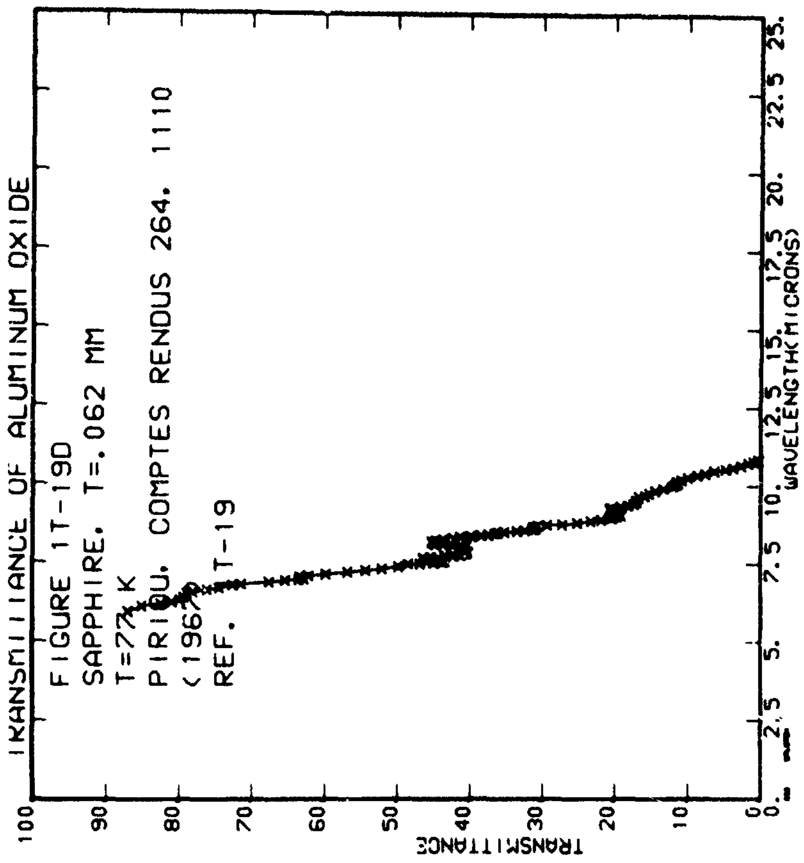
λ	T	λ	T	λ	T	λ	T
3.506	8.773E+01	3.875	8.796E+01	4.215	8.840E+01	4.432	8.898E+01
4.779	8.943E+01	4.985	8.983E+01	5.168	8.993E+01	5.322	8.975E+01
5.480	8.905E+01	5.616	8.806E+01	5.772	8.730E+01	5.922	8.628E+01
6.017	8.394E+01	6.116	8.045E+01	6.226	7.634E+01	6.318	7.185E+01
6.398	6.839E+01	6.481	6.620E+01	6.557	6.484E+01	6.596	6.264E+01
6.636	5.925E+01	6.663	5.678E+01	6.700	5.521E+01	6.745	5.392E+01
6.809	4.992E+01	6.850	4.609E+01	6.888	4.206E+01	6.932	3.906E+01
6.968	3.546E+01	7.004	3.322E+01	7.031	3.385E+01	7.061	3.467E+01
7.109	3.250E+01	7.177	2.947E+01	7.238	2.599E+01	7.297	2.261E+01
7.361	1.982E+01	7.429	1.713E+01	7.485	1.416E+01	7.534	1.201E+01
7.572	1.179E+01	7.621	1.277E+01	7.655	1.322E+01	7.714	1.218E+01
7.706	1.038E+01	7.829	9.384E+00	7.867	9.052E+00	7.908	9.800E+00
7.943	1.054E+01	8.002	1.030E+01	8.061	1.007E+01	8.091	1.102E+01
8.115	1.219E+01	8.167	1.267E+01	8.231	1.254E+01	8.295	1.132E+01
8.345	9.933E+00	8.436	8.519E+00	8.517	6.938E+00	8.573	5.458E+00
8.624	4.509E+00	8.698	4.542E+00	8.765	3.677E+00	8.852	2.612E+00
8.949	1.647E+00	9.056	9.651E-01	9.191	6.822E-01	9.282	1.997E-01


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-19C
SAPPHIRE. T=.167 MM
T=300 K
PIRIOU. COMPTES RENDUS 264. 1110
(1967)
REF. 1T-19
TRANSMITTANCE
WAVELENGTH(MICRONS)
0.
2.5
5.
7.5
10.
12.5
15.
17.5
20.
22.5
25.
0
10
20
30
40
50
60
70
80
90
100

Piriou (Ref. 1T-19)

d. Thickness = 0.062 mm, T = 77^{o}K, chemically etched surface

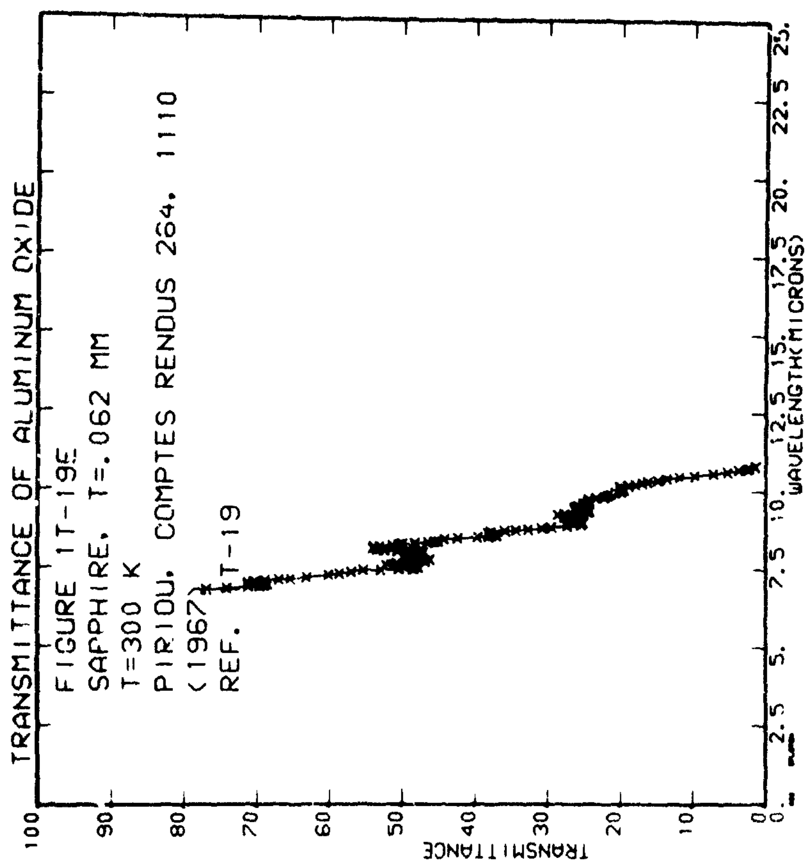
λ	T	λ	T	λ	T	λ	T
5.943	8.699E+01	6.102	8.513E+01	6.190	8.250E+01	6.239	8.109E+01
6.310	7.997E+01	6.391	7.941E+01	6.505	7.896E+01	6.566	7.814E+01
6.625	7.612E+01	6.693	7.441E+01	6.778	7.262E+01	6.815	7.147E+01
6.880	6.765E+01	6.923	6.548E+01	6.959	6.350E+01	6.989	6.281E+01
7.049	6.343E+01	7.081	6.213E+01	7.135	5.988E+01	7.203	5.684E+01
7.265	5.436E+01	7.321	5.210E+01	7.380	4.988E+01	7.450	4.846E+01
7.478	4.688E+01	7.507	4.489E+01	7.535	4.376E+01	7.571	4.345E+01
7.596	4.433E+01	7.622	4.569E+01	7.651	4.648E+01	7.690	4.549E+01
7.724	4.345E+01	7.746	4.221E+01	7.769	4.124E+01	7.804	4.060E+01
7.834	4.038E+01	7.871	4.070E+01	7.913	4.129E+01	7.946	4.141E+01
7.989	4.114E+01	8.019	4.070E+01	8.054	4.056E+01	8.075	4.134E+01
8.086	4.244E+01	8.106	4.376E+01	8.120	4.471E+01	8.152	4.509E+01
8.182	4.521E+01	8.221	4.461E+01	8.268	4.365E+01	8.296	4.227E+01
8.336	4.136E+01	8.357	3.988E+01	8.384	3.842E+01	8.415	3.745E+01
8.448	3.666E+01	8.488	3.610E+01	8.514	3.523E+01	8.540	3.359E+01
8.558	3.248E+01	8.586	3.135E+01	8.604	3.092E+01	8.635	3.109E+01
8.671	3.138E+01	8.701	3.059E+01	8.730	2.932E+01	8.772	2.727E+01
8.815	2.520E+01	8.864	2.338E+01	8.910	2.179E+01	8.963	2.038E+01
8.999	1.970E+01	9.044	1.913E+01	9.107	1.962E+01	9.151	2.014E+01
9.265	2.046E+01	9.251	2.068E+01	9.282	2.029E+01	9.324	1.916E+01
9.3[illegible]	1.810E+01	9.408	1.739E+01	9.482	1.701E+01	9.579	1.703E+01
9.625	1.672E+01	9.676	1.583E+01	9.749	1.523E+01	9.839	1.442E+01
9.915	1.330E+01	9.979	1.216E+01	10.028	1.173E+01	10.073	1.140E+01
10.136	1.157E+01	10.195	1.096E+01	10.261	1.002E+01	10.335	8.636E+00
10.397	7.504E+00	10.491	5.389E+00	10.541	4.859E+00	10.593	3.877E+00
10.668	2.779E+00	10.738	1.780E+00	10.795	1.082E+00	10.828	3.827E-01


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-19D
SAPPHIRE. T=.062 MM
T=77. K
PIRIOU. COMPTES RENDUS 264. 1110
(1967)
REF. T-19
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Piriou (Ref. 1T-19)

e. Thickness = 0.062 mm, T = 300°K, chemically etched surface

λ	T	λ	T	λ	T	λ	T
6.805	7.700E+01	6.866	7.424E+01	6.901	7.129E+01	6.923	6.973E+01
6.953	6.916E+01	6.993	6.864E+01	7.011	6.924E+01	7.020	7.038E+01
7.042	7.135E+01	7.069	7.051E+01	7.101	6.908E+01	7.131	6.706E+01
7.161	6.543E+01	7.213	6.323E+01	7.281	6.029E+01	7.338	5.873E+01
7.387	5.716E+01	7.423	5.558E+01	7.448	5.306E+01	7.474	5.053E+01
7.492	4.859E+01	7.525	4.798E+01	7.550	4.833E+01	7.575	4.998E+01
7.598	5.142E+01	7.620	5.224E+01	7.652	5.077E+01	7.688	4.968E+01
7.720	4.813E+01	7.746	4.695E+01	7.778	4.627E+01	7.814	4.726E+01
7.869	4.836E+01	7.906	4.902E+01	7.934	4.861E+01	7.960	4.786E+01
7.991	4.746E+01	8.015	4.723E+01	8.047	4.778E+01	8.054	4.932E+01
8.057	5.067E+01	8.081	5.242E+01	8.103	5.357E+01	8.134	5.409E+01
8.181	5.394E+01	8.207	5.319E+01	8.231	5.137E+01	8.253	5.040E+01
8.282	5.037E+01	8.308	4.831E+01	8.326	4.658E+01	8.349	4.569E+01
8.371	4.501E+01	8.432	4.423E+01	8.477	4.240E+01	8.514	3.979E+01
8.534	3.814E+01	8.562	3.707E+01	8.585	3.715E+01	8.596	3.775E+01
8.647	3.829E+01	8.674	3.780E+01	8.704	3.595E+01	8.738	3.441E+01
8.769	3.278E+01	8.805	3.089E+01	8.843	2.954E+01	8.888	2.735E+01
8.931	2.548E+01	8.995	2.514E+01	9.032	2.567E+01	9.090	2.679E+01
9.161	2.773E+01	9.237	2.862E+01	9.258	2.771E+01	9.292	2.570E+01
9.323	2.457E+01	9.349	2.423E+01	9.383	2.474E+01	9.419	2.461E+01
9.453	2.488E+01	9.456	2.561E+01	9.470	2.635E+01	9.502	2.609E+01
9.545	2.573E+01	9.598	2.507E+01	9.641	2.442E+01	9.716	2.439E+01
9.745	2.440E+01	9.777	2.329E+01	9.819	2.218E+01	9.867	2.177E+01
9.912	2.137E+01	9.950	2.073E+01	9.990	1.993E+01	10.039	1.957E+01
10.080	1.964E+01	10.106	2.014E+01	10.150	2.014E+01	10.186	1.896E+01
10.216	1.795E+01	10.270	1.703E+01	10.320	1.634E+01	10.353	1.493E+01
10.407	1.365E+01	10.458	1.183E+01	10.506	9.767E+00	10.575	7.238E+00
10.637	5.208E+00	10.701	3.611E+00	10.738	2.396E+00	10.765	2.130E+00
10.805	1.448E+00						


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE IT-19E
SAPPHIRE, T=.062 MM
T=300 K
PIRIOU, COMPTES RENDUS 264, 1110
(1967)
REF. IT-19
TRANSMITTANCE
WAVELENGTH(MICRONS)
0 10 20 30 40 50 60 70 80 90 100
0. 2.5 5. 7.5 10. 12.5 15. 17.5 20. 22.5 25.

Roberts (Ref. 1T-20)

The transmittance of sapphire 0.986 mm thick at T $\simeq$ 300°K (unspecified room temperature) was measured using a Czerny-Turner type grating monochromator with unspecified bandpass. Transmittance precision was unstated, but probably better than 1 percent. Data were digitized from specific points.

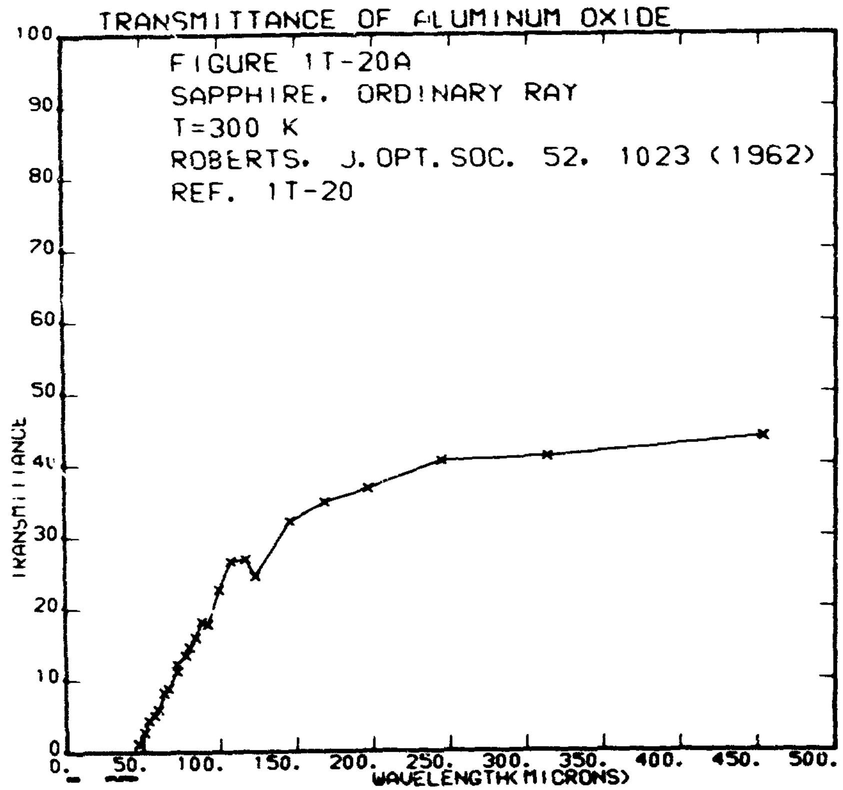
These data are in agreement with the representative curve of Section I - 1.6.

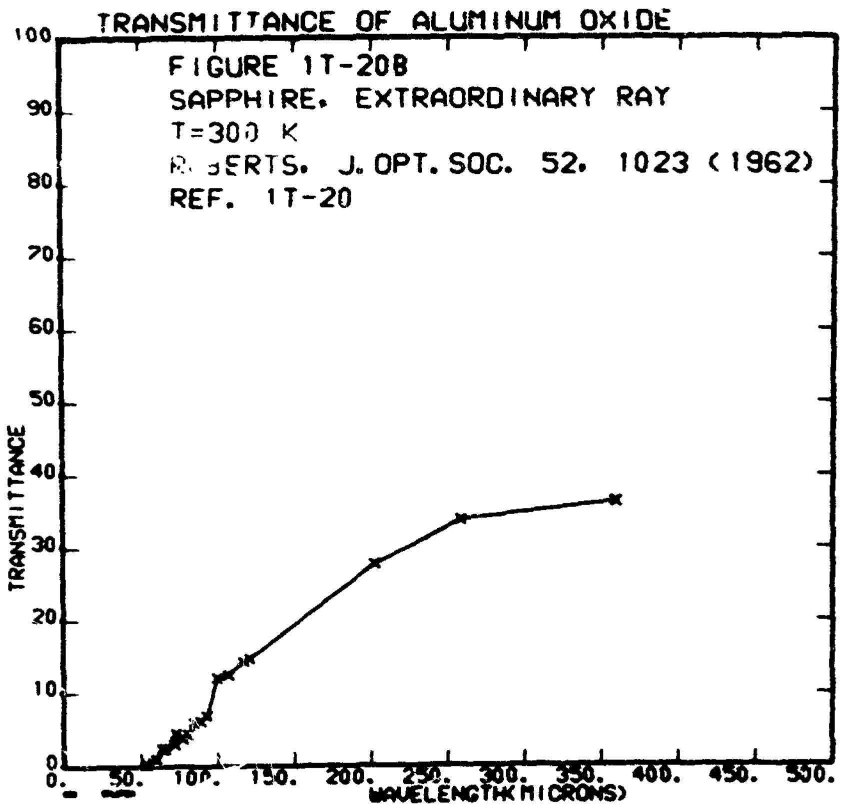
a. Ordinary ray

λ	T	λ	T	λ	T
[illegible]	5.541E+01	2551.354	5.456E+01	2243.580	5.170E+01
2?52.5?3	4.833E+01	785.313	4.573E+01	453.819	4.381E+01
313.135	4.165E+01	244.191	4.039E+01	195.810	3.661E+01
1?6.5?2	3.472E+01	145.747	3.234E+01	123.595	2.446E+01
117.235	2.667E+01	107.691	2.656E+01	99.818	2.266E+01
92.929	1.7??E+01	89.860	1.811E+01	84.563	1.598E+01
80.743	[illegible]	78.238	1.344E+01	72.853	1.227E+01
72.377	1.1?5E+01	66.496	6.880E+00	64.431	8.288E+00
[illegible]	5.934E+00	57.809	5.132E+00	54.353	4.299E+00
[illegible]	[illegible]	47.448	1.175E+00		

b. Extraordinary ray

λ	T	λ	T	λ	T
[illegible]	4.833E+01	2630.958	4.943E+01	2420.434	4.810E+01
2211.57?	4.36?E+01	1919.747	4.153E+01	617.347	3.852E+01
359.473	3.534E+01	253.483	3.387E+01	202.332	2.779E+01
1??.237	1.?74E+01	117.427	1.430E+01	107.388	1.241E+01
?9.739	1.?51E+01	93.115	6.940E+00	89.019	6.166E+00
[illegible]	5.929E+00	81.041	4.390E+00	77.597	3.862E+00
73.135	4.?99E+00	72.152	3.651E+00	65.447	2.486E+00
64.37?	2.452E+00	56.361	1.084E+00	57.864	5.920E-01
54.397	3.754E-01				


TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-20A
SAPPHIRE. ORDINARY RAY
T=300 K
ROBERTS. J. OPT. SOC. 52. 1023 (1962)
REF. 1T-20
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0 10 20 30 40 50 60 70 80 90 100

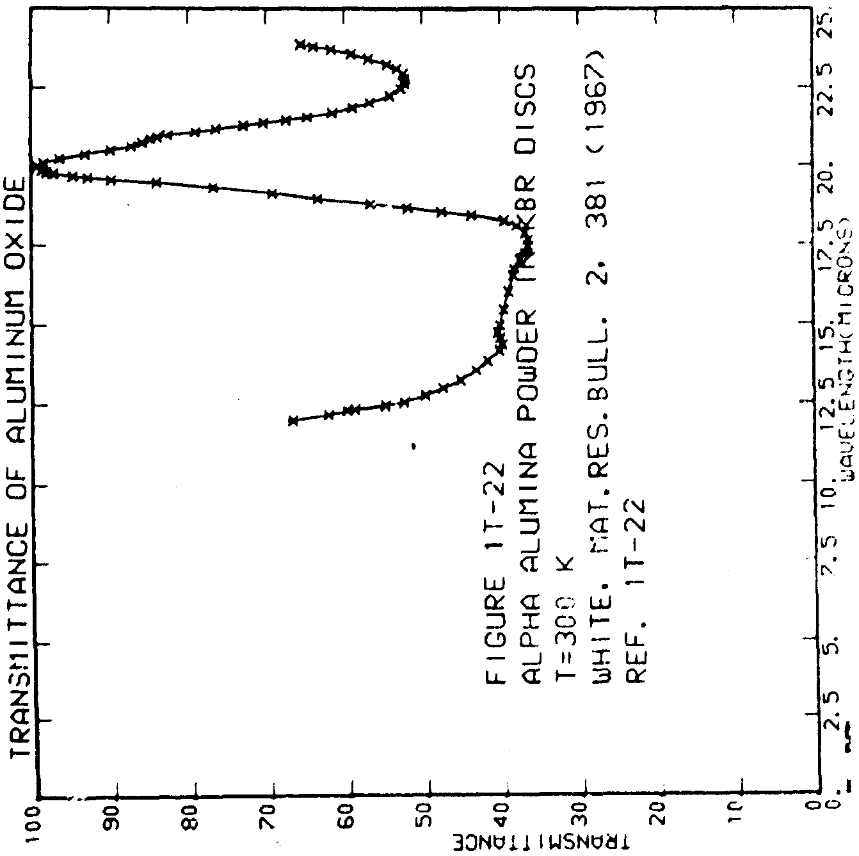

TRANSMITTANCE OF ALUMINUM OXIDE
FIGURE 1T-20B
SAPPHIRE. EXTRAORDINARY RAY
T=300 K
ROBERTS. J. OPT. SOC. 52. 1023 (1962)
REF. 1T-20
TRANSMITTANCE
WAVELENGTH(MICRONS)
0. 50. 100. 150. 200. 250. 300. 350. 400. 450. 500.
0 10 20 30 40 50 60 70 80 90 100

White (Ref. 1T-22)

The transmissivity of α - Al_2O_3 powder of unspecified size was measured between 12μ to 23μ on a Perkin-Elmer 21 spectrophotometer equipped with KBr optics. Samples were mounted in KBr pressed pellets. No error analysis was given. Data were digitized from curves.

These data were selected in part to construct the representative curve given in Section I, Figure I - 1.6c.

λ	T	λ	T	λ	T	λ	T
12.006	7.256E+01	12.019	6.680E+01	12.183	6.225E+01	12.307	5.985E+01
12.341	5.889E+01	12.450	5.492E+01	12.556	5.251E+01	12.761	4.989E+01
12.984	4.757E+01	13.247	4.520E+01	13.536	4.329E+01	13.835	4.171E+01
14.155	4.026E+01	14.355	3.984E+01	14.556	4.018E+01	14.733	4.041E+01
14.955	4.017E+01	15.463	3.965E+01	16.035	3.902E+01	16.560	3.848E+01
16.767	3.922E+01	17.024	3.752E+01	17.243	3.683E+01	17.483	3.646E+01
17.677	3.647E+01	17.884	3.689E+01	18.106	3.793E+01	18.253	3.951E+01
18.430	4.373E+01	18.545	4.758E+01	18.654	5.194E+01	18.792	5.667E+01
18.963	6.346E+01	19.126	6.919E+01	19.308	7.684E+01	19.463	8.403E+01
19.546	8.980E+01	19.619	9.288E+01	19.672	9.478E+01	19.724	9.724E+01
19.762	9.813E+01	19.929	9.872E+01	19.969	9.921E+01	20.078	9.853E+01
20.201	9.642E+01	20.368	9.311E+01	20.486	8.988E+01	20.621	8.728E+01
20.742	8.582E+01	20.859	8.474E+01	20.911	8.397E+01	20.984	8.252E+01
21.090	7.904E+01	21.190	7.644E+01	21.291	7.296E+01	21.394	7.036E+01
21.472	6.743E+01	21.567	6.478E+01	21.716	6.150E+01	21.864	5.898E+01
22.033	5.670E+01	22.266	5.412E+01	22.482	5.271E+01	22.631	5.229E+01
22.795	5.213E+01	22.968	5.231E+01	23.142	5.316E+01	23.265	5.446E+01
23.439	5.582E+01	23.590	5.902E+01	23.728	6.162E+01	23.821	6.393E+01
23.831	6.551E+01						



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